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Abstracts of world literature contained in periodicals, books, and patents

UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

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By MARY C. RABBITT *and* S. T. VESSELOWSKY

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GEOPHYSICAL ABSTRACTS 147, OCTOBER–DECEMBER 1951

By MARY C. RABBITT and S. T. VESSELOWSKY

INTRODUCTION

Geophysical Abstracts are prepared by the Geophysics Branch of the Geological Survey, United States Department of the Interior, as an aid to those engaged in geophysical research and exploration. Periodicals, books, and patents are regularly searched for material dealing with geophysical exploration and with the physics of the solid earth.

Abstracts are grouped in three sections dealing with earth physics, exploration geophysics, and patents. The first section has been further divided into sections on gravity, magnetism and electricity, seismology, radioactivity, heat, and tectonophysics, and internal constitution of the earth. The section on exploration geophysics covers gravimetric, magnetic, seismic, electric, and radioactive methods, well logging, and technical aids. Patent abstracts are taken from the Official Gazette of the U. S. Patent Office. Within each group the order of the abstracts is as follows: general papers, bibliographies, and reviews; theory; instruments; methods and techniques; observations.

As many readers may not have ready access to the source material, an effort is made to include all significant new material in these abstracts. Where geographic names quoted differ from the decisions of the United States Board on Geographic Names, the latter are added in brackets.

Geophysical Abstracts 1–86 and 112–127 were issued as Information Circulars by the Bureau of Mines, and 87–111 were issued as Bulletins of the Geological Survey. Geophysical Abstracts 128 and following numbers have been published as Bulletins of the Geological Survey.

All Geophysical Abstracts published as Information Circulars are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (except Nos. 87 and 88 which are out of print) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

For subscription, the Superintendent will accept a deposit of $5 in payment of subsequent issues. When this fund is near depletion, the subscriber will be notified. The deposit may also be used to purchase any other publication from the Superintendent of Documents.

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EARTH PHYSICS

GENERAL

13093. Conrad, Victor. A method of estimating the periodic constituent of a geophysical series: Archiv für Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 4, pp. 324–337, 1951.

A method has been devised to test for periodic constituency of a series of twelve numbers, which might correspond to the months of a year, subject to a yearly oscillation. For any series, a numerical constant, k, is evaluated. With the help of a standard curve or table in which k is evaluated as a function of percent periodicity, the latter may be determined.

Eighteen geophysical elements were analyzed for periodic constituency. They cluster about two points of the k curve. Twelve of the series cluster around 69 ± 2.5 percent. The other six crowd around 91 ± 1.8 percent periodic constituency. It is significant that the latter were all of the variation of temperature in continental climates.

It is assumed that a true annual variation would have at least 60 percent periodicity. In reality, this would be equivalent to a period of the annual variation of air pressure deduced from one year of observation. The method was also applied to twelve monthly temperature variations of each of nine hot springs. The percent constituency was divided into two groups, those above and below 60 percent periodicity. It is shown that the former group had significantly lower temperatures on the average than the latter. This is contrary to previous interpretation which indicated real annual variations for both groups.—*I. Z.*

13094. Agocs, W. B. Least squares residual anomaly determination: Geophysics, v. 16, no. 4, pp. 686–696, 1951.

The various methods for determining regional gradients and consequently residual anomalies are reviewed. Regional maps may be obtained by the method of arithmetic means, average profile, circle summation and finally, the fitting of a plane by least squares to the observed data. All of these methods are variations of a least-squares approach, the latter being especially recommended for the reduction of pseudoanomalies which sometimes appear when some other method is used. As illustrations, the residual and regional maps of a theoretical gravity field are presented using the method of arithmetic means and least squares.—*I. Z.*

GRAVITY

13095. Heiskanen, W. The world-wide gravity program of the Mapping and Charting Research Laboratory of Ohio State University: Geophysics, v. 16, no. 4, pp. 697–700, 1951.

Gravity measurements can be used for geophysical, geologic, exploration, and geodetic purposes. Gravity anomalies permit determination of the absolute undulations of the geoid and the absolute deflections of the vertical. These are the bases of a World Geodetic System, together with astronomical observations. Collecting and analyzing data by scientists of different countries is necessary to

prepare a World Geodetic System. Likewise, additional gravity surveys are needed in many parts of this country, as well as in other parts of the world.—*L. E. B.*

13096. Curtis, A. R. Elasticity correction of a pendulum used in the absolute measurement of gravity: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 3, pp. 159–162, 1951.

Elasticity corrections for a rigid pendulum are computed by considering the stretching and bending corrections separately. The stretching correction is a static one and depends only on the changes in the first and second moments of the pendulum when placed on its support. The bending correction is obtained by a simple method based on the use of the angular momentum equation. The source of error in J. S. Clark's work (Royal Soc. London Philos. Trans., ser. A, 238, 65, 1940) is pointed out and also an error in Harold Jeffreys' work (*See* Geophys. Abstract 11918) which does not affect Jeffreys' final value of g.—*H. R. J.*

13097. Morelli, Carlo. Studio del gravimetro Worden no. 50 e sua applicasione per un rilievo geofisico di dettaglio alle foci del Timavo [Investigation of the Worden gravimeter no. 50 and its use in a detailed geophysical survey at the mouth of the Timavo]: Annali Geofis., v. 4, no. 2, pp. 247–271, 1951.

This is a detailed description and discussion of the theory of the Worden gravimeter, including its adjustment and calibration, determination of drift, effect of temperature and pressure gradients, sensitivity to magnetic influences and to mechanical shocks. The instrument is compensated for variation of temperature, but not for strong temperature gradients. The drift is within -0.03 to $+0.15$ mgal per hour, the average value being to $+0.05$ mgal per hour. The accuracy of a single reading is ± 0.03 mgal. An experimental detailed gravimetric survey was made with this instrument around the Foce del Timavo, near Trieste, with 52 stations occupied. Bouguer anomalies are shown in a table and on two maps.—*S. T. V.*

13098. Selényi, P. Über die Möglichkeit einer Abänderung und Weiterentwicklung des Eötvösschen Versuches der gedrehten Waage [On the possibility of a modification and futher developement of the Eötvös experiment with torsion balance]: Hungarica Acta physica, tome 1, fasc. 1, pp. 75–83, 1951.

Among the experiments performed by Eötvös in his studies of the gravitational field was one to prove that the force of gravity to which a body is exposed when moving in the east-west direction on the earth's surface is different from that in the north-south. To detect this variation a light horizontal beam with two equal masses at its ends is suspended on a knife edge by a vertical wire with adjustable torsional reaction. If the beam is placed in a north-south direction and made to oscillate horizontally, vertical oscillations of the beam and its masses will develop after a certain time, whereas those oscillations will not be observed if the initial horizontal oscillations of the beam are on the east-west line. The vertical oscillations of the beam are caused by variations in the total gravity force acting on the moving masses resulting from slight, but measurable, increase or decrease of the term representing the centrifugal effect of the rotating earth and acting in the direction opposite to gravitational force. The effect of the various different factors are considered and the two differential equations for the horizontal and vertical oscillations of the systems are derived. To make the vertical oscilla-

tions observable it is necessary to adjust the systems so that the natural periods almost coincide. The phenomenon is related to the Foucault pendulum experiment.—*S. T. V.*

13099. Cook, A. H. The calculation of deflexions of the vertical from gravity anomalies: Royal Soc., London, Proc., ser. A, v. 204, no. 1078, pp. 374–395, 1950.

The studies of the errors in the calculations of deflections of the vertical show that quite useful calculations may be made by using Jeffreys' determination of the lower harmonics of the free-air anomalies to give the contribution to the deflection from most of the world, the local part being found by using Stokes's integral over a cap of 10 of 15 degrees radius. Estimates of deflections are made for Greenwich, Herstmonceux, Southampton, and Bayeux. Although at present the uncertainties of the deflections calculated are very large, they would be considerably reduced if gravity measurements were made in the South Pacific.—*L. E. B.*

13100. Wegener, Kurt. Die Schwere in Gebirge. [Gravity in mountains]: Geofis. Pura e Appl., v. 19, fasc. 3–4, pp. 124–128, 1951.

From gravity determinations at sea made by Vening Meinesz and Cassinis, it is concluded that the force of gravity over the lowlands of continental sialic masses is the same as that over ocean depths of 5000 m where the bottom is sima. Thus where the ocean bottom is covered with sial there must be a gravity deficiency. From the value of gravity force at a point of ocean surface and the corresponding depth, it is possible to tell whether the mountains rising from the bottom, but not reaching the ocean surface, are formed of sima or sial. As examples, gravity profiles across the Atlantic Ocean and the Pacific in the vicinity of the Hawaiian Islands are discussed. Bouguer anomalies of different mountain systems such as the Alps, the Himalayas, the Rockies, the Caucasian and central Asian ridges are also discussed. The author concludes that the greatest thickness of sial is normally found at the periphery of mountain systems and remains constant under the whole area.—*S. T. V.*

13101. Huaux, Aimé. Sur des déplacements concomitants de l'axe instantané de rotation et de l'axe principal instantané d'inertie de la Terre. [On the simultaneous displacements of the instantaneous axis of rotation and of the principal instantaneous axis of inertia of the earth]: Acad. royale Belgique Bull., Cl. sci., 5th ser., tome 37, no. 2, pp. 53–55, 1951.

The changes in the position of the principal axis of inertia of the rotating earth, caused by the seasonal displacement of the masses of the air contained between the latitudes 5° and 65° north and south of the equator, are computed in view of their influence on the displacement of the axis and it is concluded that the pole of inertia describes a trajectory contained in the rectangle of dimensions 0.15″ by 0.05″.—*S. T. V.*

13102. Melchior, P. J., and Huaux, Aimé. Sur le déplacement annuel par rapport au globe terrestre de l'axe de rotation de la terre, en relation avec une oscillation annuelle de l'axe principal instantané d'inertie de la terre [On the annual displacement of the rotational axis of the earth within the earth in relation to the annual oscillation of the principal instantaneous axis of inertia of the earth]: Acad. royale Belgique Bull., Cl. sci., 5th ser., tome 37, no. 2, pp. 155–177, 1951.

Both authors have recently studied the periodic displacements of the pole of inertia of the earth. Huaux investigating the effect of seasonal displacements of atmospheric masses and Melchior the displacement on the basis of observations collected by the Service International des Latitudes during the last 50 years. The agreement in the results obtained from these separate studies is good. It is evident that the earth cannot be treated as a rigid body in precise determinations, and that displacement of the air masses is not the only factor to be taken into account.—*S. T. V.*

13103. Carreño, Alfonso de la O. Cartas de anomalías de la gravedad en la República Mexicana. [Maps of gravity anomalies in Mexico]: Soc. geol. mexicana Bol., tomo 14, pp. 23–38, 1949.

This is a reprint of the article abstracted in Geophys. Abstract 12145. An index has been added.—*L. E. B.*

13104. Thirlaway, H. I. S. Measurements of gravity in Ireland. Gravimeter observations between Dublin, Sligo, Galway and Cork: Dublin Inst. Advanced Studies, Geophys. Mem. no. 2, pt. 2, 26 pp., 1951.

Gravity traverses between the pendulum stations of Dublin, Sligo, Galway, and Cork and a regional gravity survey of Leinster and a small area centered on Kingscourt, County Cavan, have been made using a Graf-Askania gravimeter with stations observed at 4 to 8 mile intervals. Results are given as Bouguer anomaly maps.

The outstanding feature is the decrease in anomaly of 2.3 mgals per mile from the east coast to the Leinster granite, with the lines of equal anomaly being closely parallel to the geologic strike. Over the Leinster and Galway granites, the plain west of Dublin, and the Devonian rocks of Cork and Kerry, the anomalies are low relative to the rest of the field and are either negative or very nearly zero. The lower Paleozoic rocks in the east and in the vicinity of Carrick-macross, the area south and southeast of Sligo and south of Galway are high-anomaly areas, the anomalies on the east coast, however, being nearly twice any other. In general, the lines of equal anomaly trend northeast parallel to the geologic strike in the north where Caledonian folding predominates and have an east-west trend over the Amorican folding in the south. Isostatic anomalies are in many places larger than the Bouguer anomalies, but are less than 25 mgal except for a strip along the east coast.

The gravity anomaly on the Welsh coast is repeated with almost perfect symmetry on the Irish coast. These anomalies and the negative observation in the Irish Sea may be explained as resulting from thickening of lower Paleozoic sediments and the presence of a land mass in the Irish Channel during development of the Paleozoic geosyncline or as a compressional rift structure of the channel.—*M. C. R.*

13105. Solaini, Luigi, and Cunietti, Mariano. Rilievo gravimetrico del Comune di Milano [The gravimetric survey of the comune of Milan]: Riv. Geofis. Appl., v. 12, no. 1, pp. 1–13, 1951.

This is a brief report on the gravimetric survey made by the Istituto di Geofisica Applicata del Politecnico di Milano, over an area of about 150 sq km of the commune of Milan. A Western G4 A gravimeter was used, and 220 stations were occupied. The whole area was divided into six polygons, the closing errors in each found being negligible. The report gives details on the computations involved and contains three maps of the area with observed anomalies contoured

at intervals of 0.5 mgal and residual anomalies contoured at 0.25, and 0.125 mgal. Free air and Bouguer reductions were applied, but the topographic correction was omitted as the area surveyed is essentially flat. The major anomaly is negative and roughly circular with a radius of about 10 km; the maximum absolute value of the anomaly is 1.4 mgal.—*S. T. V.*

13106. Iida, Kumizi, Hayakawa, Masami, and Katayose, K. Changes of gravity difference between Imaichi and Nikkō owing to the "Imaichi Earthquake" [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 3, pp. 20–22, 1950.

Gravity differences between Imaichi and Nikkō [Tochigi-ken] were measured immediately after and three months after the Imaichi earthquake of December 26, 1949, using a North American gravimeter. Changes of about 2 mgals in the gravity difference between Imaichi and Nikkō were found, which may have been the effect of the earthquake.—*M. C. R.*

13107. Glennie, E. A. The Cuddapah basin in India and crustal warping: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 3, pp. 168–176, 1951.

The Cuddapah basin, which is a crescent-shaped area of about 14,000 sq mi. roughly between 14° and 17° N. lat and 78° and 80° E. long., is of particular interest because gravity determinations show a marked defect of gravity over the basin as compared with that over the surrounding region, although the rocks in both areas have normal density. The bottom of the basin has been contoured from geologic data and found to slope eastward to a maximum depth of more than 18,000 ft. The defect in gravity is then ascribed to a downwarping of the crust, which is assumed to have a total thickness of 30 km. Computation of the effect of downwarping to 18,000 ft gives results consistent with the gravity data.—*M. C. R.*

MAGNETISM AND ELECTRICITY

13108. Chapman, Sydney. The earth's magnetism, 2d edition, 126 pp., London, Methuen and Co., Ltd., 1951.

The revised second edition of this monograph is a brief description of the present knowledge of the earth's magnetic field and its changes, using limited mathematical developments.—*L. E. B.*

13109. Berlage, H. P. The fundamental relation between the magnetic moment and the structure of rotating celestial bodies: Nature, v. 165, no. 4189, pp. 242–243, 1950.

Blackett's hypothesis predicting a linear relation between the magnetic moment of a rotating celestial body and its angular momentum is arrived at through another consideration. These celestial globes are assumed to possess a nucleus of degenerate matter from which free electrons migrate into outer shells more easily than the positive ions. As a consequence of this development, the mean temperature of the sun is determined to be about 15,000,000°, which is of the right order of magnitude.—*I. Z.*

13110. De Barr, A. E. Magnetic materials and ferromagnetism: Reaserch, v. 4, no. 8, pp. 366–371, 1951.

Recent developments in the domain theory of ferromagnetism and the properties of some newer magnetic materials used in the construction of physical instruments

are discussed. According to the domain hypothesis, a ferromagnetic material is made up of small particles, or domains, of two different linear dimensions, one about 10^{-2} cm and another of 10^{-6} cm. In each of these domains the material is magnetized to saturation along a particular crystallographic direction. Change in magnetization of the material can take place either by domain boundary displacement or by rotation of the direction of magnetization in each domain. Most technically important magnetic properties are determined by the factors affecting change of magnetization in a domain, such as magnetocrystalline anisotropy, magnetostriction, and impurities and internal strain in the material.—*S. T. V.*

13111. Aarts, W. H. A new hysteresis effect in magnetism: South African Jour. Sci., v. 48, no. 4, pp. 124–126, 1951.

Positive and negative magnetostriction is a lengthening and shortening respectively of a material by the application of a longitudinal magnetic field. Certain combinations of magnetic fields can twist a specimen, and, conversely, torsion plus a circular field can produce a longitudinal field. Experimentally this was done by twisting a cylindrical specimen while passing a current from end to end. With iron a decrease in the circular field (that is, switching off the current) resulted in a decrease in the longitudinal field. However, for steel and nickel the longitudinal field was increased when the current was sufficiently large. With nickel it was also found that a switching on and off of the current produced successively higher fields until a steady state was reached after five cycles.

Measurement of the longitudinal magnetic field is more accurately determined by a suspended needle magnetometer than by a search coil and ballistic galvanometer.—*W. J. D.*

13112. Tsubokawa, Ietsune. Theory of electromagnetic magnetometer using rotating coil-detectors: Geog. Survey Inst. Japan Bull., v. 2, pt. 4, pp. 277–324, 1951.

Magnetometers discussed consist of a rotating detector coil whose output is amplified and a Helmholtz-Gaugain coil mounted on a theodolite. (*See* Geophys. Abstracts 12359 and 12628.)

Either the direction of the axis of rotation of the rotating detector coil or the central axis of the H–G coil can be read on the horizontal and vertical circles of the theodolite. In the second case the axis of rotation is always at right angles to the H–G coil. In measuring the three elements of the geomagnetic field, declination and dip are determined with no field produced in the H–G coil and Z and H are determined by orienting the H–G coil in the direction of the component to be measured and observing the field necessary to null these components, or by measuring the angles between a resultant field produced by the known field of the H–G coil and the vertical axis and the horizontal plane. Similarly, the total field can be measured by the two methods.

If the angle between the H–G coil and the axis of rotation is kept more than 80°, the coil constant of the H–G field in that direction can be computed to 10^{-6}, or better than is required for one gamma accuracy.

Contribution of lead-in wires is calculated to be zero when the coils are wound in opposite sense, and 1×10^{-4} for φ equals 6° or 0 when φ equals 0 if the coils are wound in the same sense; $90-\varphi$ is the angle between the central axis of H–G coil and axis of detector rotation.

The accuracy of magnetometers of this type is limited by the sensitivities of the detector, the theodolite spirit level and the accuracy of the vertical and horizontal circles.—*W. J. D.*

13113. Tsubokawa, Ietsune. G. S. I. precise (First Order) magnetometer: Geog. Survey Inst. Japan Bull., v. 2, pt. 4, pp. 325–360, 1951.

Magnetometers of the Helmholtz-Gaugain coil and rotating detector type having an accuracy of 0.1′ in dip and declination and 1 gamma in intensity have been constructed. These are of the design which measure the dip of the resultant field when a known field of the H–G coil is superimposed on the earth's total field.

Electrical and mechanical details of construction are given together with instructions for setting up the instrument and making observations. A comparison of readings between two of these instruments and observatory magnetograms is shown and the accuracy is with the specified limits.—*W. J. D.*

13114. Kato, Yoshio, and Tanaka, Toshio. On a new astatic magnetometer used for measurement of magnetic properties of rocks: Tōhoku Univ. Sci. Rept. 5th ser. Geophysics, v. 3, no. 2, pp. 102-106, 1951.

The remanent magnetization of a specimen is measured by rotating it inside a magnetic shield constructed of high-permeability material and observing the deflection of a small suspended magnet at the center of the shield. The mathematical theory of the instrument is presented as well as graphs of the instrument sensitivity and of measurements of a typical specimen.—*J. R. B.*

13115. Wijk, A. M. van, and Gotsman, B. Note on the use of the quartz horizontal-force magnetometer for the determination of magnetic declination: South African Jour. Sci., v. 47, no. 11, pp. 316-318, 1951.

The QHM consists of a small magnetic needle suspended by a vertical quartz fiber and a telescope to read the position of the needle by means of a mirror also attached to the suspension fiber. Known torsions are exerted on the quartz fiber by turning the suspension through radians. From the angular changes in needle position and the constants of the instrument, the horizontal magnetic intensity can be determined. Because it weighs only 1½ lb and exhibits very low drift, the QHM is especially good for making international comparisons of horizontal intensity standards. By observing the horizontal intensity with varying amounts of torsion it is also possible to find the mean index error for zero torsion and thus determine declination. One complete observation, six conditions of torsion, for declination can be made in nine minutes. Tables show the results for typical determinations under ideal conditions.—*W. J. D.*

13116. Kuboki, Tadao. On the temperature compensation of a magnetic variometer by means of a magnetic shunt alloy (Abstract): Kakioka Magnetic Observatory Mem., v. 6, no. 1, pp. 64–65, 1951.

It has been possible to keep the temperature compensation of the magnetic variometer as small as 0.0γ per degree Centigrade by means of a magnetic shunt alloy of Fe-Ni-Cr system made in the Tōhoku University Metal Matter Laboratory. This alloy has the following characteristics: one magnetic Curie point at 100–150 C, a very large temperature coefficient of permeability, and a linear relation between permeability and temperature in the interval 10–600 C. These characteristics are not changed by cold work, cooling, heating, or similar processes. For the simple bar magnet, considered to be the best for the magnetic variometer, the condition necessary to make the temperature-coefficient zero is

$$V = V_o(Q_1 + Q_2)/N\alpha,$$

where Q_1 and Q_2 are the temperature coefficients of magnetic moment and of the quartz fiber's rigidity; N is the demagnetization factor, V_o the volume of the magnet, V, the volume of the shunt alloy, and α the temperature coefficient of the permeability of the shunt alloy.

A portable variometer using the shunt alloy has also been constructed. It can be used in fields where the change of temperature is 10 to 20 C, is very stable and the accuracy is about 0.5γ.—*M. C. R.*

13117. Krasnogorskaĭa, N. V. Investigation of conditions under which Kubetskiĭ's multiplicator can be used for measuring of magnetic field [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, pp. 43–50, 1951.

A theoretical study has been made of the possibility of using Kubetskiĭ's electronic tube for measurements of rapid changes of geomagnetic field, such as those due to the action of solar protuberances, of meteorites passing near the atmosphere, or to processes deep in the earth. The instrument consists of a photoelectric element with several amplifiers in series. The current passing through the anode of the instrument is affected by the changes of the magnetic field to which the tube is exposed and thus can be used for the measurement of these changes. An important feature of the instrument is the absence of inertia, making it adaptable for measurement of rapid changes. From an analysis of the tube in its present construction it is concluded that it can be conveniently used for the purpose. The measurable range of variations of the field is 3×10^{-5} oersted to 1.3 oersted. Disturbing magnetic waves of frequency less than 1 sec can be detected on the instrument.—*S. T. V.*

13118. Finger, D. L. The effect of alternating compressive stresses on magnetic properties of magnetite [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 5, pp. 51–67, 1951.

The influence of mechanical stresses on the magnetic properties of magnetite and some ferronickel alloys has been studied experimentally by placing samples inside a magnetometer coil and exposing them to tensile or compressive stresses which were either kept constant or oscillating within certain limits. An astatic magnetometer with vertical coils, of a sensitivity equal to 0.4 maxwell per mm of scale was used and the intensity of magnetic field surrounding the samples ranged from zero to 60 oersted.

The following conclusions were drawn from the tests: Under simultaneous action of a constant magnetic field and an alternating elastic stress of decreasing intensity, the intensity of magnetization in all samples of magnetite and ferrous alloys increased in a measure proportional to the intensity of exerted stress, and the remanent magnetism was also increased; a constant compressive stress produced a decrease of magnetization; the coefficient of the decrease of magnetic susceptibility with increasing constant compression ranged from -0.0002 to -0.0011.

The first conclusion may explain the greater natural values of magnetism of rock as compared with laboratory data as caused by mechanical stresses produced by earthquakes or by tectonic deformation.—*S. T. V.*

13119. Nagata, Takesi. Natural remanent magnetism of igneous rocks and its mode of development: Nature, v. 165, no. 4189, pp. 245–246, 1950.

The intense natural remanent magnetization of rocks can be produced only by their cooling in the geomagnetic field from a temperature higher than their Curie point. If a rock in a weak magnetic field is cooled from T_1 to T_2 below its Curie point, its remanent magnetization will increase on further cooling even if the magnetic field is removed. This change is reversible with change of temperature, provided T_2 is not exceeded, and may correspond to the reversible change in the spontaneous magnetization of magnetic domains. If the magnetic field

is less than one oersted, the remanent magnetization at t (less than T_2) produced by cooling from T_1 to T_2 in the field F can be expressed as

$$\int_{T_1}^{T_2}(F,t)\simeq F\int_{T_2}^{T_1} I(T,t)\psi(T)dT$$

where $T=(T_1-T_2)/2$, $I(T, t)$ is the intensity of spontaneous magnetization of the magnetic domains at t and $F\psi(T)$ is the probability of the orientation of domain vectors in the direction of the magnetic field F.—*J. R. B.*

13120. Weaver, J. D. A possible connection between certain metamorphic phenomena and anomalies in the earth's magnetic field: Science, v. 114, no. 2965, pp. 434–435, 1951.

The two variables, temperature and pressure, are inadequate to explain mineralogical changes and orientation effects that accompany metamorphism. The author suggests consideration of the local geomagnetic field as another factor. This suggestion is based on presence of magnetic anomalies in volcanic and tectonically active areas and reports that, in experiments on the synthesis of mica, introduction of a weak magnetic field facilitated the growth of large sheets. Experiments on the effect of magnetic fields on crystallizing minerals and detailed studies of magnetic phenomena in tectonically active areas are proposed as fields for future investigations.—*J. L. M.*

13121. Kato, Yoshio. Report of the geophysical party of the solar eclipse expedition of Tōhoku University on observation of terrestrial magnetic field at Nemuro, Onagawa and Katsuura: Tōhoku Univ. Sci. Repts., 5th ser., Geophysics, v. 3, no. 2, pp. 57–73, 1951.

The effect of the solar eclipse of September 12, 1950, was investigated at Nemuro, Onagawa and Katsuura, Japan, by observing the declination and horizontal components of the magnetic field and dH/dt of the three components. At the eclipse, the observed declination was considerably less than that of the following day, a day of normal magnetic activity. The residual field calculated from the deviation of the horizontal component and declination of September 12 from that of September 13, is illustrated along with the position of the shadow by the moon for the times of 11^h, 12^h, 13^h, 14^h, in the ionosphere at a height of 100 km. According to S. Chapman, the residual field may be explained by a residual current system by considering the decrease of conductivity in the ionosphere in the area of the shadow of the moon at the time of the eclipse. There is good correlation between observed and computed residual fields.

The ratio of the amplitudes of micropulsation of $(dH/dt)_{EW}$ and $(dH/dt)_{NS}$ of every two stations is plotted as a function of time. The amplitude ratio of Nemuro-Onagawa and Nemuro-Katsuura is large at the time of maximum phase of the eclipse. This is attributed to the effects of an S_d current system by the solar eclipse.—*I. Z.*

13122. Sparkman, J. W., Jr. Geomagnetic conditions and anticyclonic development: Am. Met. Soc. Bull., v. 32, no. 8, pp. 282–288, 1951.

A relationship exists between changes of the horizontal component of the geomagnetic field and the development of anticyclonic pressure systems over the eastern United States. Statistical studies show that the existence for the same local mean times of high horizontal intensity values at Cheltenham, Md. and low values at Tucson, Ariz., in contrast with previous days, indicates an increase in anticyclonic central pressure 24 to 48 hr later over the eastern

United States. Further studies of the hours between midnight and noon show the horizontal intensity values immediately after sunrise give the best indication of anticyclonic developments 36 to 48 hr later.—*J. L. M.*

13123. Imamiti, Syuiti. One of the universal variations of geomagnetic field [In Japanese with English abstract]: Kakioka Magnetic Observatory Mem. v. 6, no. 1, pp. 18-23, 1951.

There are rather strong, sharp variations (called provisionally peak variations) in the geomagnetic field. The amplitude of this peak variation is large at the time of magnetic storms and smaller on calm days, and a single variation generally does not continue more than 20 min. The peak variation vectors all over the world except at higher latitudes are almost parallel to each other, and their magnitudes increase as the stations approach the auroral zones. It is believed that this peak variation is due to Birkeland's ring current at the auroral zone; its height is estimated as 2000 km, and its position at latitude of 70°.—*M. C. R.*

13124. Martyn, D. F. The theory of magnetic storms and auroras: Nature, v. 167, no. 4238, pp. 92–94, 1951.

By treating the flow of an ionized stream past a magnetic dipole as analogous to a streamline flow around a submerged obstacle, an attempt is made to explain phenomena not satisfactorily accounted for by the prevailing theories of magnetic storms. Presumably, there would be a hollow space surrounding the dipole having a computed radius of 5.5 earth radii. The steady state of flow of the stream past and around the earth sets up a toroidal ring current which, by its momentum, remains after the stream ceases to flow. The radius of the circular cross section of the ring current, calculated from the decrease in H in the main phase of an average magnetic storm, is approximately equal to the diameter of the earth. Unstable charges on the surface of the ring under an expellent field of 10^{-3} v per cm and guided to the auroral zone by the magnetic field possess sufficient energy to penetrate the atmosphere to the 90–100 km levels and produce luminescence (auroras). The main features of the S_D- field are accounted for by a polarization field set up by a Hall current in the auroral zone. The current system of bay disturbances can be accounted for in the same manner as the S_D- field, provided the necessary current system is advanced in phase by 6 hr.—*R. G. H.*

13125. Alfvén, Hannes. "The theory of magnetic storms and auroras" [Letter to the Editor]: Nature, v. 167, no. 4259, p. 984, 1951.

The writer is critical of the Chapman-Ferraro theory of magnetic storms and of the superstructure erected upon it by D. F. Martyn in his paper, "The theory of magnetic storms and auroras" (Geophys. Abstract 13124). The field of electric currents in gases is complicated by the numerous factors that may enter. Too often Nature differs with the investigator on what factors are essential in a particular phenomenon. Geophysicists would do well to check their theoretically derived results by laboratory experiment. Scale model experiments, for example, lead to important understandings of geophysical phenomena.—*R. G. H.*

13126. Hirayama, Misao. Classification of magnetic disturbances (Abstract): Kakioka Magnetic Observatory Mem., v. 6, no. 1, p. 66, 1951.

In an attempt to establish a classification, the disturbances on the 1948–49 records at Kakioka were divided into 4 groups: bay disturbances, impulsive

disturbances, oscillations, and irregular disturbances. On the basis of this investigation, impulsive and irregular disturbances showed tendencies similar to the bay disturbances in the course of day. Further investigations are being made using the records at other observatories.—*M. C. R.*

13127. Ferraro, V. C. A., and Parkinson, W. C. Sudden Commencements in geomagnetism: their dependence on local time and geomagnetic longitude: Nature, v. 165, no. 4189, pp. 243–244, 1950.

Newton, in 1948, found the diurnal frequency of occurrence of sudden commencements associated with geomagnetic disturbances at Greenwich had a broad minimum around 8 hr. Data from magnetic observatories at the same latitude confirmed the 8 hr minimum, while those in low latitudes had an 8 hr minimum apparent only for sudden commencements that are followed by large or moderate disturbances. The frequency of occurrence of the type of sudden commencements where the increase in H is preceded by a small preliminary movement in the opposite direction, is believed to depend on universal time, and generally this type is more frequent in the hours following 12 hr G. m. t. This suggests a possible dependence on geomagnetic longitude.—*L. E. B.*

13128. Chakrabarty, S. K. "Sudden Commencements" in geomagnetic field variations: Nature, v. 167, no. 4236, p. 31, 1951.

Alībāg Observatory's records from 1905–44 have been analyzed for data on sudden commencements in geomagnetic field variations. The first type, characterized by a rise in H and a fall in V, is very prominent; the second type, where the increase in H is preceded by a small movement in the opposite direction, is absent in Alībāg. The third type, called "inverted sudden commencements" does occur at Alībāg but the frequency is small.

Graphs of the diurnal variation of the incidence of sudden commencements at Alībāg show a minimum between 4 and 7^h and about 17^h local time and a more prominent maximum between 9^h and 15^h. Some sudden commencements recorded at Alībāg have not been recorded at Abinger Observatory. Although sudden commencements are possibly a world-wide phenomenon, the data analyzed at different observatories are not uniform and are influenced by local effects.—*L. E. B.*

13129. McIntosh, D. H. Geomagnetic "sudden commencements" at Lerwick: Atmospheric and Terrestrial Physics Jour., v. 1, no. 4, pp. 223–232, 1951.

A study of sudden commencements occurring at Lerwick from April 1934–December 1949 shows that the form of the sudden commencement has little connection with the size of following disturbance but the amplitude of the main impulse of the sudden commencement is related to some extent to the size of the following disturbance. The sudden commencements are rather more frequent during the equinox than during the winter or summer and there is a relation between the annual number of sudden commencements and the mean annual sunspot number and a measure of the annual magnetic activity. The form taken by the sudden commencements is much more varied than has been found for stations in lower latitudes, but a definite variation is found in the form of sudden commencement according to time of occurrence. The average of all Lerwick sudden commencements is shown to be opposed to the main disturbance field.—*L. E. B.*

13130. Bondarenko, A. P. Some evidence on the causes of telluric currents [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, pp. 40–42, 1951.

Telluric currents were measured during the summers of 1939–40 in two areas, one in the region of the known positive magnetic anomaly near Kremenchug,

Ukrainian S. S. R., the other some 75 miles away in an area of normal magnetic characteristics. In each place of observation the measuring lines were 1 km long, one being placed in the geographic meridian, the other along the latitude circle. From the results of the measurements of telluric currents, daily variations of their components in the N-S and E-W directions were computed. Simultaneously observations at the Stepanovka magnetic observatory, about 250 miles away, were similarly recorded and analyzed. There is a close similarity between graphs of telluric currents and of magnetic variation, but with a phase difference of $1^h\ 30^m$ to 2^h. Variation in phase displacements of two curves is attributed to differences in the electrical resistivity of the ground in places of observation.—*S. T. V.*

13131. Hirayama, Misao. Earth current due to stress [Abstract]: Kakioka Magnetic Observatory Mem., v. 6, no. 1, p. 68, 1951.

In the summer of 1944, while recording the earth potential gradient and induced current in a horizontal loop in an investigation of the pulsations in the earth's magnetic field at Yabuki-machi, Fukushima-ken, a change of 1 to 2 mv per km in the earth potential gradient was always recorded when the train was running at a distance of about 300 m from the nearest electrode. This is considered to be due to the potential of flow produced by the stress of the soil weighed down by the train.—*M. C. R.*

13132. Yoshimatsu, Takasaburo. Changes of earth-current potentials at Kanoya and activities of volcano Sakurajima [In Japanese with English abstract]: Kakioka Magnetic Observatory Mem., v. 6, no. 1, pp. 31–35, 1951.

Between June and September 1950, minor volcanic activity on Sakura-jima, as reported by the Kagoshima Meteorological Observatory, occurred in four periods: from the end of June to early in July; several days before and after July 25; early in August; and from the end of August to early in September. During these periods of volcanic activity both east and north components of earth potentials changed markedly at Kanoya, about 27 km southeast of the volcano. Volcanic microtremors occurred more frequently during periods of larger earth potentials, at least from the end of January to the middle of June.—*M. C. R.*

13133. Yokouchi, Yukio. On the storms of earth-current potentials observed at Kakioka [In Japanese with English abstract]: Kakioka Magnetic Observatory Mem., v. 6, no. 1, pp. 42–53, 1951.

From 1934 to 1942, 266 sudden-commencement storms of earth-current potentials were recorded at Kakioka. The mean storm-time variation is similar to that in geomagnetism. The direction and duration of sudden change at the time of occurrence, as obtained from frequency curves, are E. 10°N. and 3.5 min respectively. The mean duration of storms is 30 hr.—*M. C. R.*

13134. Yanagihara, Kazuo. Earth-resistivity near the Kakioka Magnetic Observatory [In Japanese with English abstract]: Kakioka Magnetic Observatory Mem., v. 6, no. 1, pp. 36–41, 1951.

Earth resistivity has been measured since April 1948 at the Kakioka Magnetic Observatory, using the Wenner-Gish-Rooney method with several systems of electrode arrangement and base length. The field equipment, method, and apparatus and some preliminary experiments are described in this paper. It was found

that both the direct-current method and low-frequency ratio-meter method gave the same results within 3 to 5 percent. No diurnal variation of the resistivity was found. Monthly mean values are tabulated.—*M. C. R.*

13135. Kitamura, Masatoshi. On the result of observation of the earthing-resistance [English abstract]: Kakioka Magnetic Observatory Mem., v. 6, no. 1, pp. 54–61, 1951.

From systematic observations made monthly from 1947 to 1950 with a Kohlrausch bridge, it has been found that the contact resistance between electrodes and the soil in which they are placed decreases as the earth temperature increases, or as the amount of precipitation increases more than about 200 mm. Thus it follows that the seasonal variation can be considered to be chiefly the result of changes in the concentration, and consequently conductivity, of the solution surrounding the electrodes resulting from changes of earth temperature or ground water.—*M. C. R.*

13136. Fritsch, Volker. Blitzschläge im Gebirge [Lightning strokes in mountainous regions]: Geofis. Pura e Appl., v. 17, pp. 199–203, 1950.

Observations in Saxony and Austria on the frequency of lightning strokes in different regions show that the higher site is not always the most vulnerable; geologic structure is more important. The fact that the more ancient formations are struck most is probably explained by the electrical properties of these formations. The ratio of strokes observed in pre-Cambrian rock to those in Paleozoic schist and in Quaternary deposits is 11:7.3:5.6. Maps of Austria and Saxony showing the relative danger to lightning of the different zones are included.—*S. T. V.*

13137. Grabovskiĭ, M. A. Variation of the electrical resistivity of magnetite under magnetization [In Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, pp. 61–70, 1951.

Several samples of magnetite were tested for electrical resistivity at different temperatures and it was found that with temperature increasing from room temperature to about 200 C the resistivity drops from 30 ohms to about 0.5 ohms. The process was not reversible and on cooling the resistivity came back to only 14 ohms and after several days to 16 ohms. The samples of magnetite were also tested for the effect of magnetic field on their electrical resistivity. The description of the experimental arrangement for the measurement of galvanomagnetic effect is given. It was established that with increasing intensity of the surrounding magnetic field the resistivity decreases independently of the direction of the magnetic field.

From the results of his experiments the author concludes that among the causes of telluric currents the variation of the geomagnetic field must be taken into account as well as possible variation of temperature.—*S. T. V.*

13138. Katō, Yoshio, and Noritomi, Kazuo. The thermal variation of the electrical conductivity of rocks: Tōhoku Univ. Sci. Rept., 5th ser., Geophysics, v. 3, no. 2, pp. 107–109, 1951.

The variation of electrical conductivity with increasing temperature was measured for a few specimens of granitic rocks. The log of the conductivity varied linearly with the reciprocal of the absolute temperature but showed a sharp change in slope at about 600 C. This change in slope may represent either the

inversion from low to high quartz or the increasing importance of the second term in Koch and Wagner's theoretical formula for conductivity in ionic crystals.—*D. F. B.*

SEISMOLOGY

13139. Roberts, E. B., and Ulrich, F. P. Seismological activities of the U. S. Coast and Geodetic Survey in 1949: Seismol. Soc. America Bull., v. 41, no. 3, pp. 205–220, 1949.

Included in this article are reports on the teleseismic program, the questionnaire program, principal earthquakes of the United States during 1949, strong-motion, vibration and tiltmeter work, and instrument development.—*M.C. R.*

13140. Tillotson, Ernest. Seismology in Great Britain, 1949–1950: Nature, v. 167, no. 4247, p. 475, 1951.

Dollar's catalogue of Scottish earthquakes and Longuet-Higgins and Darbyshire's work on microseisms are briefly summarized. Work at the Imperial College of Science and Technology, London, on elastic properties of rocks at frequencies between 40 and 120 cycles per second, the Leeds University work on ground amplitudes and frequencies resulting from blasting, and Stoneley's discussion of the effect of a low-velocity layer on amplitudes of surface waves are mentioned also.—*M. C. R.*

13141. Förtsch, Otto. Untersuchungen von Biegewellen in Platten. Messung ihrer Gruppen und Phasengeschwindigkeit [Investigations of flexural waves in plates. The measurement of their group and phase velocities]: Gerlands Beitr. Geophysik, Band 61, Heft 4, pp. 272–290, 1950.

The propagation of elastic waves through a layer of ice covering a lake was studied experimentally during the winter of 1943. It was found that elastic motions of the ice caused by a sharp impact were flexural waves. The observed dispersion curve corresponded to theory. Wave velocity was found to be half the measured phase velocity, as predicted by theory. In the frequency range of 3 to 60 cycles per second, measured velocities follow the theoretical law within limits of observational error; it may be assumed that the same holds true for frequencies as high as 1000 cycles per second.—*M. C. R.*

13142. Angenheister, G. H. Fortschreitende elastische Wellen in planparallelen Platten. [Propagation of elastic waves in plane-parallel plates]: Gerlands Beitr. Geophysik, Band 61, Heft 4, pp. 296–308, 1950.

According to the theory of the propagation of elastic waves in plates as given by Lamb, there are both symmetrical and unsymmetrical oscillations with respect to the middle plane of the plate. When the wave length is small in comparison with the thickness of the plate the velocity of both approaches the velocity of the Rayleigh wave. When the wave length is longer, the velocity of the symmetrical oscillations approaches a limit which lies between 1.63 and 2.00 times the velocity of transverse waves. The unsymmetrical waves are flexural waves if their wave length is long in comparison with the thickness of the plate.

Three measurements of flexural waves in plates of ice covering a lake show that these waves fulfill the theoretical law of dispersion. Computed thicknesses of the ice, however, are smaller than measured values, the discrepancy being great when the temperature is near 0 C.—*S. T. V.*

13143. Zaitsev, L. P., and Zvolinskiĭ, N. V. Investigation of the frontal wave appearing on the boundary of two elastic media [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, pp. 20–39, 1951.

When a wave with a non-plane front is incident on the boundary between two elastic media, there is generated in addition to the reflected and refracted waves a third wave which has a rectilinear front and is propagated through the lower-velocity medium. Dynamic relations controlling the propagation of this wave are studied, limiting the analysis to longitudinally polarized waves. Two cases are discussed, with the source of vibrations in the medium of lower velocity, and in the second medium. Differential equations are derived for the propagation of each of the three waves, following the method of Smirnov and Sobolev.

The results of the study are as follows: The intensity of the frontal wave as it reaches any point of the plane increases along the front line in the direction toward the point of contact with the front of the reflected wave; the intensity of the frontal wave decreases with distance of the point of observation from the epicenter in the relation $\xi^{3/2}$; vertical displacements in the reflected wave decrease in the same ratio, but horizontal displacements only in the ratio $\xi^{1/2}$; the amplitude of the reflected wave with the spreading of the wave front tends to zero and later becomes negative, so that there are points on the plane where the amplitude of the reflected wave becomes very small and only the frontal wave is registered.—*S. T. V.*

13144. Zaitsev, L. P., and Zvolinskiĭ, N. V. Investigation of the axis-symmetrical front wave, generated on the plane boundary of two elastic liquids [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 5, pp. 40–50, 1951.

This is the continuation of the study on the propagation of the plane front wave in a two-dimensional space [*see* Geophys. Abstract 13143]. In the present paper the propagation of longitudinal waves produced by an expansible point source in a medium composed of two infinite semispaces separated by a plane is discussed. The velocities of propagation of seismic waves in these semispaces are different; the point source exciting waves is placed in the space of the lower velocity.

The solution is obtained by the method worked out by V. I. Smirnov and S. L. Sobolev using complex variables. First the displacement potentials are written down for the incoming, reflected, and refracted waves. The wave equations established in the first study are transformed to a new reference plane, the problem remaining two dimensional. The boundary conditions of the new equations remain the same, but the equations describing initial conditions at the point source are to be changed accordingly.

In the final solution equations are obtained for all three waves. The solutions are only approximate, but give the path of the waves very accurately.—*S. T. V.*

13145. Haskell, Norman. The dispersion of surface waves on multilayered media: U. S. Air Force, Cambridge Research Center, Geophys. Research Paper, no. 9, 28 pp., 1951.

A matrix formalism developed by W. T. Thomson is used to obtain the phase-velocity dispersion equations for elastic surface waves of Rayleigh and Love type on multilayered solid media. The method is used to compute phase and group velocities of Rayleigh waves for two assumed three-layer and one two-layer model of the earth's crust in the continents. The computed group velocity curves are compared with published values of the group velocities at various frequencies of Rayleigh waves over continental paths. The scatter of the observed values is larger than the difference between the three computed curves. It is believed that not all of this scatter is due to observational errors but probably represents a real horizontal heterogeneity of the continental crusts.—*Author's abstract.*

13146. Press, Frank, and Ewing, Maurice. Propagation of elastic waves in a floating ice sheet: Am. Geophys. Union Trans., v. 32, no. 5, pp. 673–678, 1951.

The characteristic equation for the propagation of elastic waves in a floating ice sheet is derived. Since the solution cannot be reduced to symmetric and antisymmetric modes as in the case of a plate in a vacuum or liquid, the evaluation of phase velocities of intermediate wave lengths is exceedingly difficult. Solutions are obtained, however, at very low wave lengths, which reduce to Rayleigh and Stoneley waves, and at very large wave lengths, which are longitudinal and flexual waves. A solution for Love waves is also obtained.—*D. F. B.*

13147. Gassmann, Fritz. Elastic waves through a packing of spheres: Geophysics, v. 16, no. 4, pp. 673–685, 1951.

Based on a theory of porous solids previously developed by the author, the elasticity of a hexagonal close packing of equal spheres is treated. The packing is anisotropic and because of the weight of the spheres, also inhomogeneous. The velocities of propagation of elastic waves have been calculated for evacuated interspaces and for interspaces filled with a liquid or gas. In the case of evacuated or air-filled interspaces, the wave rays and travel times have been computed. The packing which has been treated may be of use as a model for a dry or wet loose material such as gravel or sand. Though the model is very simplified, the results obtained show some typical effects such as anisotropy, inhomogeneity, and a 90° angle of emergence.—*Author's abstract.*

13148. Gassmann, Fritz. Elastizität poröser Medien [Elasticity of porous media]: Schweizer. naturf. Gessell. Verh. v. 130, pp. 135–136, 1950.

This is the summary of the paper, presented at the convention of the society in Davos, August 1950, discussing the analysis of changes in elastic properties of a porous medium caused by filling the pores with a fluid. Results of theoretical studies show that if in a dry sandstone the velocity of longitudinal seismic waves is 2.3 kmps, this velocity will be increased to 2.75 kmps if the pores are filled with water. Detailed results of the study will be presented later.—*S. T. V.*

13149. Hughes, D. S. and Cross, J. H. Elastic wave velocities at high pressures and temperatures: Geophysics, v. 16, no. 4, pp. 577–593, 1951.

Dilatational and rotational velocities in rock samples have been measured at pressures from 1 to 5,000 bars and temperatures of 25 C to 200 C (300 C for two samples), using pulse methods [*see also* Geophys. Abstracts 12231 and 12232]. Specimens studied were the Twin Sisters dunite, Quincy granite, Barriefield granite, Cheshire quartzite, Danby marble, Solenhofen limestone, Caplen Dome sandstone, an argillaceous limestone, and a calcareous shale. Measured rotational velocities check well with other measurements at lower frequencies by Birch. Poisson's ratio has been calculated from the measured velocities. Values in the quartzite were 0.13 to 0.14; in the calcareous shale, 0.18; in dry sandstone, 0.20 to 0.25; in all others, greater than 0.3. The effect of interstitial water on velocity was observed on one sandstone and one limestone specimen. In the sandstone, presence of water apparently increased the velocity at low pressure and reduced the rate of increase with pressure; behavior in the limestone was effectively the opposite.—*M. C. R.*

13150. Bullen, K. E. Theoretical amplitudes of the seismic phase *PKJKP*: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 3, pp. 163–167, 1951.

The partitioning of energy of P waves incident from above against the boundary of the earth's inner core and of P and SV waves incident from below has been calculated, assuming an inner core with rigidity as in an earth model based on compressibility theory, and the calculations have been used to estimate the relative amplitudes of $PKJKP$ and $PKIKP$ at different epicentral distances. $PKJKP$ is most likely to be observed between 130° and 155° in which range the amplitude is about one-fifth that of $PKIKP$.—*M. C. R.*

13151. Caloi, Pietro. Teoria delle onde Rayleigh in mezzi elastici e firmo-elastici, esposta con le omografie vettoriali [Theory of Rayleigh waves in elastic and firmo-viscous media, developed by the means of vectorial operators]: Archiv für Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 4, pp. 413–435, 1951.

The propagation of waves at the surface of an elastic, isotropic, infinite medium is studied using vectorial treatment, and the theory is then extended to a firmo-viscous medium (that is, one with internal friction).

It was found that the velocity of propagation of Rayleigh waves in the firmo-viscous is infinite for very high frequency waves, but as μ/μ' increases tends towards a value corresponding to the purely elastic medium. (Here μ is the Lamé constant and μ' the coefficient of internal friction.)

The firmo-viscosity of the medium produces a noticeable reduction of the vertical component of the wave's amplitude, especially for the small values of μ/μ' and high frequency waves. The ratio of the vertical to horizontal amplitudes in a purely elastic medium is 1.47, while in a firmo-viscous medium this ratio increases from 1.05 to 1.47 when $\lambda=\mu$.

As in a purely elastic medium in the firmo-viscous one, the particles in the path of Rayleigh waves have elliptic paths, but with deflected axes of the ellipse.

Rayleigh waves propagating through a medium with internal friction have a high degree of absorption, especially those of high frequency. Computed absorption coefficients show good agreement with observations.—*S. T. V.*

13152. Förtsch, Otto. Analyse der seismischen Registrierungen der Grosssprengung bei Haslach im Schwarzwald am 28 April 1948 [Analysis of the seismograms of the great explosion at Haslach in the Black Forest on April 28, 1948]: Geol. Jahrb., Band 66, pp. 65–80, 1951.

Detailed study of the records has shown a great number of onsets of different waves. Among these are second onsets of longitudinal and transverse waves following first arrivals by a definite time interval. Four layers have been determined from the observations: granite, in which the velocities of longitudinal, transverse, and Rayleigh waves are 5.88, 3.39, and 3.09 kmps; diorite, in which the velocities are 6.005, 3.47, and 3.20 kmps; gabbro, in which the velocities are 6.55, 3.78 and 3.39 kmps; and peridotite, in which the velocities are 8.34, 4.82, and 4.31 kmps. A cross section of the earth's crust between Haslach and Füssen, based on seismic, gravimetric, and magnetic measurements, is included.—*M. C. R.*

13153. Oliver, J. E., and Drake, C. L. Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part VI: The Long Island area: Geol. Soc. America Bull., v. 62, no. 11, pp. 1287–1296, 1951.

On the basis of data from a seismic survey, consisting of 12 reversed refraction profiles in the waters around Long Island and from a few wells in eastern Long Island, a contour map of the crystalline rock surface has been drawn. This sur-

face is approximated by a plane dipping south to southeast at about 55 ft per mile. Relief of 200 to 300 ft has been found on the basement surface. Velocity in the basement varies from 5.3 to 6.0 kmps with a mean of 5.6 kmps. Other mean velocities observed were 1.65 kmps in unconsolidated sediments and 2.0 kmps in semiconsolidated sediments, the latter found only south and southeast of the island.—*M. C. R.*

13154. Hales, A. L., and Willmore, P. L. Crustal layers of the earth: Nature, v. 168, no. 4265, pp. 163–164, 1951.

Hales takes exception to Willmore's statement [*see* Geophys. Abstract 12947 for reference] that in South Africa a tendency for waves to arrive early at distances beyond 120 km is associated with the exposure of high-velocity rock in the region where the onsets are observed. A well-defined early *P* phase between 220 and 300 km in western Transvaal studies is cited as evidence of crustal layers increasing in basicity with depth either as a continuous variation of composition or discontinuous change because: geologic maps do not show a distribution of formations consistent with the idea of a single-layer crust with thin cover of high-velocity material near the field stations; lack of correspondingly early *S* phases suggests a change in the ratio of longitudinal and transverse velocities; and observations of the distances at which phases totally reflected at the Mohorovičić discontinuity appear agree satisfactorily with the two-layer hypothesis. Willmore's note points out the existence, at least in parts of the area, of 5,000 or more feet of the Vetensdorp series, the properties of which are very similar to those required for the high-velocity material, and states again that "it seems premature to assert horizontal stratification provides the only possible explanation of the results."—*M. C. R.*

13155. Hodgson, J. H., and Milne, W. G. Direction of faulting in certain earthquakes of the north Pacific: Seismol. Soc. America Bull., v. 41, no. 3, pp. 221–242, 1951.

Byerly's method of determining direction of faulting from the distribution of initial compressions and rarefactions has been applied to four north Pacific earthquakes, one in the Aleutians, one in central Alaska, one in the Queen Charlotte Islands, and one in Vancouver Island. The Aleutian earthquake of April 1, 1946 could have resulted from motion along a fault striking N. 65° W. and dipping 65° to the north, or more probably a fault striking N. 22° 30′ E. and dipping 85° to the west, the east side moving north with respect to the west side. The central Alaska earthquake of October 16, 1947 most probably occurred on a normal fault striking N. 30° W. and dipping 78° to the northeast. The Queen Charlotte Islands shock of August 22, 1949 may have occurred along a fault striking N. 29° W. and dipping 77° to the northeast, with the Pacific side moving north relative to the continent, or a fault striking N. 64° E., dipping 92° south, with the south side moving east. The former is more probable geologically. The British Columbia earthquake of June 23, 1946, occurred on a gravity fault striking north-northwest. There is no conclusive evidence, however, regarding the exact strike or dip.—*M. C. R.*

13156. Teixeira, Carlos. Ã propos d'une hypothése sur la structure de l'Océan Atlantique [On a hypothesis of the structure of the Atlantic Ocean]: Univ. Lisboa Fac. Cien. Museu e Lab. Mineralog. e Geol. Bol., 6th ser., no. 18, pp. 69–80, 1950.

Rothé's hypothesis that the Atlantic is divided by the median ridge into two different types of structure is considered and rejected. The geophysical evidence

cited includes the velocities of surface waves recorded at Lisbon from shocks in the mid-Atlantic, similarity in seismicity and submarine topography on two sides of the ridge, and similarity in gravity anomalies, except for the negative anomalies in the Antilles. Geologic evidence, the nature of the rocks in Atlantic islands and obtained by dragging operations, is also considered and shown to be consistent with the idea that Atlantic structure is the same east and west of the ridge.—*M. C. R.*

13157. Murphy, L. M. and Ulrich, F. P. United States earthquakes 1948: U. S. Coast and Geodetic Survey, Serial no. 746, 50 pp., 1951.

This is the latest in the series of annual summaries of earthquake activity in the United States and regions under its jurisdiction. Included are noninstrumental reports of earthquakes in the United States, Alaska, Hawaii, Panama Canal Zone, and Puerto Rico, a table of the principal earthquakes of the world during 1948, and analyses of strong motion records. The most severe shocks (intensity 7 on the modified Mercalli scale) in the U. S. during 1948 were those of December 4, with epicenter near Desert Hot Springs, Calif.; December 29, with epicenter near Verdi, Nev.; and December 31, with epicenter about 10 miles east of Watsonville, Calif. Shocks of intensity 6 occurred in Wyoming, near the New Mexico-Texas-Oklahoma border, near Boulder City, Nev., and in several parts of California.—*M. C. R.*

13158. Dollar, A. T. J. Catalogue of Scottish earthquakes, 1916–1949: Geol. Soc. Glasgow Trans., v. 21, pt. 2 (1947–1949), pp. 283–361, 1951.

The catolog contains a description of 120 earthquakes originating in Scotland, and 4 originating outside Scotland but felt within the country, between January 1, 1916, and April 30, 1949. Eight items of information are tabulated for each entry: British Earthquake Inquiry reference number, name of shaken area, date, time, intensity (Rossi-Forel), area disturbed, general character (duration, associated sounds, and other phenomena), and the most accessible reference. There are five broad seismic regions with marked activity and four regions of lesser seismic activity, all in central Scotland. Other factors discussed are the annual, monthly, and daily distributions, sequences of shocks, durations, intensities, disturbed areas and effects.—*L. E. B.*

13159. Janczewski, E. W. The problem of underground shocks observed in the Polish coal basin and methods of studying these phenomena [in Polish]: Państwowy Instyt. Geol., Śląskiej stacji geofizycznej w Raciborzu Biul. 1, pp. 25–54, 1950.

In the Silesian coal basin, numerous, often catastrophic, rock bursts have occurred in the mines. The cause of these rock bursts is to be found in the tectonic character of the basin, which combined with processes of erosion and sedimentation, has produced instability of underground formations.

Several recently observed rock bursts are described and the methods of observation discussed. Seismologically, the rock bursts are tectonic earthquakes with very shallow foci. They can be studied only on the basis of seismological evidence obtained from an extended network of seismic stations covering the whole basin. For determination of the foci of these shocks, the methods of Kovesligethy and Inglada are recommended. A Galitzin seismograph with a one- or two-second period is suggested as an appropriate instrument. Details of the still incomplete network of seismic stations are also discussed.—*S. T. V.*

13160. Stenz, Edward. On the suggested correlation between the rock bursts and the changes of atmospheric pressure [in Polish]: Państwowy Instyt. Geol., Śląskiej stacji geofizycznej w Raciborzu Biul. 1, pp. 55–61, 1950.

To investigate the possibility of predicting rock bursts the relation between the occurrence of rock bursts and changes of barometric pressure over the Silesian coal basin was studied using seismograph records of the geophysical station of Bytom for 1929–1935. The 2800 seismic shocks observed during this period of time were analyzed in relation to the hourly barometric readings and the annual averages of the atmospheric pressure. Because of the lack of microbarometric readings at Bytom, the mean barometric pressure over the corresponding latitude was used, and the general seismic activity of the crust at the point of observation resulting from remote earthquakes or from microseismic factors was not eliminated. The coefficient of correlation between occurrences of shocks and annual averages of pressure is 0.48 ± 0.15; between shocks and hourly readings -0.68 ± 0.07. The study will be repeated using data from the recently installed microbarometer and more complete observations of seismic shocks from extended network of seismic stations in the Silesian coal basin.—*S. T. V.*

13161. Krige, L. J., and Maree, B. D. Earthquakes in South Africa: South Africa Dept. Mines, Geol. Ser., Bull. 20, 14 pp., 1951.

Eleven earthquakes which occurred between 1938 and 1944 were investigated, chiefly on the basis of questionnaire post cards circulated shortly after each shock, and the epicenters and isoseismal lines determined for each. The maximum intensity observed was 6 on the modified Mercalli scale. Several shocks could be related to known geologic structures but most were probably related to vertical movements affecting the entire subcontinent.—*M. C. R.*

13162. Tillotson, Ernest. The great Assam earthquake of August 15, 1950: Nature, v. 167, no. 4239, pp. 128–130, 1951.

This earthquake, apparently the greatest since seismological observations have been made, occurred at $14^h\ 09^m\ 30^s$ G. m. t. August 15, 1950. The epicenter, as calculated by Rothé and Peterschmitt at Strasbourg, was near 28.6° N. lat., 96.5° E. long., which is in Assam near the borders of India and Tibet. The epicenter is somewhat to the northeast of the major seismic zone of Assam and at the junction of the north-northeast-south-southwest structural axes of Burma and east-west structural axes of the Himalayas. The magnitude of the shock was 8.6. Some 20,000 sq mi of Assam territory were seriously affected by the earthquake and subsequent floods, and damage may amount to 20 million pounds in Assam alone—*M. C. R.*

13163. Kingdon-Ward, F. Notes on the Assam earthquake: Nature, v. 167, no. 4239, pp. 130–131, 1951.

This is an eye-witness account of the occurrence of one of the greatest earthquakes near the epicenter. Capt. Kingdon-Ward and his wife were camped on the left bank of the Luhit River at approximately 28°30′ N. lat., 97°00′ E. long. at the time of the August 15 earthquake.—*M. C. R.*

13164. Auden, J. B. Note on the earthquake tremors at Shāhkot, Sheikhupura District, Punjab, of September 1943: India Geol. Survey, Records, v. 78, pt. 1, pp. 135–140, 1949.

From September 2 to 10, 1943, minor earthquakes were felt in the neighborhood of Shāhkot village, Sheikhūpura district, Punjab. However no shocks

were recorded on the Dehra Dūn seismograph during this time and no shocks have been recorded during historic time from the Shāhkot area. According to geodetic data collected by the India Survey, the Shāhkot area lies in a region of positive geodetic anomalies and near the junction of two upwarps. The shocks may have been caused by differential movements between the upwarps, differential movement between the principal upwarp and downwarp to the north, or slight slipping of the alluvial strata.—*L. E. B.*

13165. Inouye, Win. On seismic sea wave warning systems. [In Japanese with English résumé]: Tokyo Geog. Soc., Geog. Jour., v. 60, no. 1, pp. 23–26, 1951.

Some aspects of a seismic sea wave warning system off the Northeastern coast of Japan organized in September 1941 and the one for the Pacific ordered after the great Aleutian earthquake of April 1, 1946 are described.

A preliminary short note about the system now in action in Japan is also added.

Some details about Hawaiian tsunamis and studies on a tidal gauge specially constructed for the warning of tsunamis and a new phase observed in seismic records of submarine earthquakes are noted.—*Author's English résumé.*

RADIOACTIVITY

13166. Gráf, Tibor. On the radioactivity of K^{40}: Arkiv för Fysik, Band 3, Häfte 1–3, pp. 171–208, 1951.

There exist great discrepancies among the experimental determinations of the half life of K^{40}. Some published values would make the temperature of earth's crust in the past too high, while the assumption of other values would make the history of the earth surprisingly short. An attempt has been made to improve experimental technique, taking into account all possible sources of errors or inaccuracies, and using an X-ray method similar to that of Bleuler and Gabriel, but with the filling gas of the Geiger-Müller counter itself as a selective detector. The source was placed directly on the inner walls of the counter which was filled alternately with two gases, one possessing low, the other high efficiency for the $K\alpha$ X-rays of argon. Argon and krypton were used for this purpose, the first as low-efficiency gas, the second as the most suitable high-efficiency one. The upper limit of about 0.02 was found for the branching ratio between electron capture and β decay. With this value and the previously measured value of the specific β activity of potassium, the total half life of K^{40} is found to be $(1.33 \pm 0.08) \times 10^9$ years, in good agreement with the value of Houtermans and others.—*S. T. V.*

13167. Birch, Francis. Recent work on the radioactivity of potassium and some related geophysical problems: Jour. Geophys. Research, v. 56, no. 1, pp. 107–126, 1951.

The half life of K^{40} now appears fixed at 1.3×10^9 years, with an uncertainty of about 10 percent. About 12 percent of the disintegration forms A^{40} by K capture, while 88 percent results in Ca^{40} by β emission. The mean energy released per disintegration is 0.71 Mev, yielding 27×10^{-6} calories per gram year of ordinary potassium at the present time. With these constants, the production of the A^{40} of the atmosphere, heat production by potassium in the earth, and measurement of age are discussed. Ample quantities of A^{40} have been produced, but release to the atmosphere involves uncertainties. A large part of the heat conducted to the surface of the earth may be generated by potassium decay. The exist-

ence of reasonably reliable decay constants should encourage additional efforts to obtain ages of potassium minerals.—*Author's abstract.*

13168. Poole, J. H. J., and Delaney, C. F. G. Origin of atmospheric argon and the radioactive decay constants of potassium-40: Nature, v. 167, no. 4252, pp. 680–681, 1951.

Because of the difficulty in reconciling the amount of argon in the atmosphere, recent determinations of the decay constants of K^{40}, and the probable upper limit of the amount of igneous rocks denuded during geologic time, it must be concluded either that atmospheric argon is not derived from K^{40} in the crust, or that if the low branching ratio of K^{40} is correct, argon can escape from a considerable depth in the crust. A theory which postulates slow convection currents in the substratum would give a plausible explanation of the phenomenon as it might mean a small percentage of the argon generated in quite a considerable fraction of the earth's volume could escape by volcanoes and similar means during geologic time.—*M. C. R.*

13169. Burton, V. L., and Sullivan, G. R. Carbon content and radioactivity of marine rocks: Am. Geophys. Union Trans., v. 32, no. 6, pp. 881–884, 1951.

The carbon content and beta activity due to uranium and thorium have been determined for 315 samples of eight sedimentary formations, two sandstones, two limestones, and four shales. Carbon contents of nine cores of a Miocene shale from the Los Angeles Basin range from 2.56 to 12.8 percent, and the radioactivities from 2.98 to 13.5 beta counts per minute, the correlation suggesting a concentration of radioactivity in the sediments with higher organic contents. Similar relations for other formations, though based on fewer samples, suggests a genetic relationship between uranium, thorium, and carbon content.—*M. C. R.*

13170. Boganik, N. S. Radioactive disintegration and the radioactive method of the determination of the absolute geologic age of rocks and minerals. Discussed by A. P. Vinogradov, I. M. Frank, and I. E. Starik [in Russian]: Akad. Nauk SSSR Izv., Ser. geol. no. 4, pp. 57–75, 1951.

According to the author, the opinion that the rate of radioactive disintegration of different substances is constant and independent of exterior conditions and can thus form the basis of the determinations of geologic age is wrong. It is "idealistic," and contradicts the teaching of V. I. Lenin as expressed in his book "Materialism and Empiriocritisism." The author indicates discrepancies in the findings of different geophysicists in their determinations of geologic age by the method.

According to Vinogradov, classic experiments of Curie, Rutherford, Vernadskiĭ and others performed with most precise methods, for instance optical studies of pleochroism, and experiments performed under widely varying conditions have positively proved that the radioactive method is the most accurate in geologic chronology. Therefore the rate of nuclear disintegration of heavy elements is to be considered as a fundamental constant of nature. Possible variations of its value are too small to be measured. Only under artificial conditions created in laboratories, but never found in geologic history, can this radioactive disintegration be accelerated.

Frank agrees with Boganik that it would be erroneous to consider the rate of radioactive disintegration as a kind of absolute constant which cannot be changed by any exterior conditions, but similar statements were never made by reputable physicists. This rate can be changed and the process of nuclear disintegration

influenced, but only under artificially created conditions. It would be highly improbable that such conditions existed in geologic history. Contradictions in the results obtained by different scientists must be studied and will probably be explained without rejecting the radioactive method.

Starik points out that it has been proven that thermodynamic conditions during the history of the earth cannot have produced any change in the rate of radioactive disintegration of such elements as uranium, actinium, or thorium. The rate in lighter elements, such as beryllium or tritium, can have been changed by less than 1 percent. Therefore, the radioactive method remains the most accurate and reliable method of geologic chronology.—*S. T. V.*

13171. Flint, R. F. Dating Late-Pleistocene events by means of Radiocarbon: Nature, v. 167, no. 4256, pp. 833–834, 1951.

Flint discusses the origins of radiocarbon (C^{14}), the methods of assay, possible errors in date determination, and general results of tests made. Radiocarbon is of particular importance in Pleistocene research and the importance of radiocarbon dating lies in the fact that such dating is absolute and world-wide.—*L. E. B.*

HEAT

13172. Kraskovskiĭ, S. A. The average temperature gradient in the earth's crust [in Russian]: Vses. Geogr. Obsch. Izv., tom 83, no. 5, pp. 523–525, 1951.

The temperature gradient of the crust is generally assumed to be 32 C per km. This value is found to be much too high and its appearance in geophysical literature is attributed to the fact that most measurements of the gradient have been made in carboniferous or sedimentary formations with lower heat conductivity than the crystalline rocks. The average value of the temperature gradient of the crust should be taken 10 to 12 C per km and that value used in computations of the heat balance of the earth.—*S. T. V.*

13173. Benfield, A. E. The temperature in an accumulating snowfield: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 3, pp. 139–147, 1951.

The distribution of temperature below the surface of an accumulating snowfield is investigated mathematically. The controlling differential equation for temperature in a semi-infinite solid whose surface is rising with a constant velocity, v, is solved with the aid of the Laplace transform. The diffusivity is assumed constant and the surface temperature is assumed to vary sinusoidally with time. The calculations show that the annual temperature wave, if accompanied by rapid accumulation of snow, produces lower temperatures in the firn than would obtain if there were no accumulation. The problem of an ablating snowfield can be treated in a similar way by changing the algebraic sign of v, provided ablation occurs without melting. It is found that the problem involving a diffusivity which increases with depth may also be treated approximately as equivalent to a problem of negative velocity of accumulation.—*R. G. H.*

13174. Misener, A. D., Thompson, L. G. D., and Uffen, R. J. Terrestrial heat flow in Ontario and Quebec: Am. Geophys. Union Trans., v. 32, no. 5, pp. 729–738, 1951.

About 1,000 measurements of true rock temperatures, correct to 0.1 F, have been made, using platinum resistance thermometers and thermistor resistance thermometers, at various depths in mine workings in eight regions of Ontario

and Quebec [*see* Geophys. Abstracts 9863 and 12587]. Heat flow for each region has been computed from the average vertical temperature gradients and thermal conductivity measurements of approximately 300 rock specimens collected near the points of temperature measurement. The values obtained lie between 0.69×10^{-6} and 1.05×10^{-6} cal. Best values and probable errors as determined by statistical analysis and rejection criteria indicate the difference in values is real, and that regions with higher temperature gradients also have greater heat flow. If a difference in the rate of radioactive heat production between granitic and basaltic rocks of 3 to 4×10^{-3} cal per cm^3 per sec is assumed, a difference of 7 to 10 km in the thickness of the granitic layer would produce a difference in heat flow at the surface of 0.3×10^{-6} cal per cm^2 per sec. As recent gravity observations in western Ontario have been interpreted as indicating warpings at the base of the granitic and intermediate layers, variations in heat flow may reasonably be attributed to warpings at the base of the granitic layer.—*M. C. R.*

13175. Haraguchi, Kuman, Fukui, Saburō, Makiyama, Jirō, and Nakagawa, Chūzō. Report on the Hot Spring researches at Goshiki Spa and Shionoha Spa, Kawakamimura, Yoshino-gun Nara prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 4, pp. 37–40, 1950.

Temperatures of 30 and 31 C have been measured in the springs of Shionoha and Goshiki-yu. The origin of the springs is apparently closely related to a quartz-porphyry intrusion.—*M. C. R.*

VOLCANOLOGY

13176. Hantke, Gustav. Übersicht über die vulkanische Tätigkeit 1941–47 [Review of volcanic activity 1941–47]: Bull. volcanologique, ser. 2, tome 11, pp. 161–208, 1951.

Volcanic activity during the years 1941–1947 is reviewed with separate data for individual countries. For every eruption chronological data as well as available information on explosive and effusive activity, composition of lava, and seismic phenomena accompanying eruptions, are given.—*S. T. V.*

13177. Finch, R. H., and Macdonald, G. A. Report of the Hawaiian Volcano Observatory for 1948 and 1949: U. S. Geol. Survey Bull. 974–D, pp. 103–133, 1950.

Work at the Hawaiian Volcano Observatory for the years 1948 and 1949 is summarized. Data from five seismographs showed there was an average of 5 earthquakes per week, with a decided increase in the daily number preceding the January 1949 eruption of Mauna Loa. Two tiltmeters recorded variations in tilt, both in the east-west and north-south directions. The accumulated north-south net tilt for 2 years was 5.6 seconds to the south, while there was no significant accumulation of east-west tilt for that period. Periodic measurements were made of the width of certain cracks in and near the Kilauea caldera to determine closing or opening due to pressure or tilt. Radiation observations were made with a Geiger-Müller counter on hot lava flows in February 1949. The number of counts per minute ranged from 38 to 45, approximately the same count obtained on local prehistoric lavas. Temperature measurements of escaping steam and of rainfall were continued.

A special study of Mauna Loa was made during its 1949 eruption and a brief account of its summit eruption is given, listing in chronological order the various phases and lava flows.—*L. E. B.*

13178. Georgalas, G. C., and Papastamatiou, J. Über den Ausbruch des Santorinvulkanes von 1939–1941. Der Ktenas-Ausbruch [The eruption of the Santorin volcano in 1939–1941. Ktenas eruption]: Bull. volcanologique, ser. 2, tome 11, pp. 3–40, 1951.

Santorin, which had been dormant for more than eleven years, became active again in August 1939. In this report a preparatory stage from August 20 to September 22, 1939, is distinguished from the following period of intensive explosive and extrusive activity to November 25. During the first period, fissuring of the domes covering the volcano was observed, accompanied by the appearance of fumaroles. Frequent underground detonations were heard, followed by the slight sagging of lava masses covering the older domes. The temperature of the water in the springs on the slopes of the volcano increased substantially; two measurements of the temperature of the sea water in the bay showed a rise of 23–24 C to 50 and 52 C. The most important phenomenon during this preparatory period was the formation of the new dome, with an insignificant stream of lava from it.

From September 23 to November 25, eruptive activity became very intense, resulting again in the formation of a new dome. The authors were in the position to observe the volcanic activity during this whole period and their observations of various phases are presented in the form of a detailed log book, containing also 44 pictures and two topographic maps of the area.

The results of chemical analysis of the lava flowing from the new domes are also given. Additional observations on the later period of eruption will be presented in a subsequent report.—*S. T. V.*

13179. Minakami, Takeshi, Ishikawa, Toshio, and Yagi, Kenzo. The 1944 eruption of volcano Usu in Hokkaido, Japan: Bull. volcanologique, ser. 2, tome 11, pp. 45–160, 1951.

This is a compilation of several reports on the eruption that began with a series of severe earthquakes on December 28, 1943, and ended in September 1945, following the formation of a parasitic double dome on the northeastern side. The reports include studies of the geologic history of the volcano, a general description of the eruption, seismometric observations, topographic deformation accompanying the eruption, magnetic investigations, petrology, and "forerunning phenomena." A bibliography of 90 items is appended.—*M. C. R.*

13180. Sawamura, Kōnosuke. On the volcanic activity of Mt. Mihara, Izu Ōshima Is. in 1950. [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 3, pp. 55–64, 1950.

The volcano Mihara-yama, on Ō-shima began erupting July 16, 1950, after a ten-year period of quiet. The eruption was similar to that of the preceding large-scale eruption in 1912, a quiet eruption commonly observed in basaltic volcanoes. The eruption started with the formation of a small opening in the upper portion of the old crater wall, from which the lava flowed down like a waterfall accompanied by small explosions. Two days later this activity stopped and lava flowed out as a lava spring from the bottom of the old crater. On July 22, the new crater again became active and after August 2, the eruption began to have some regularity, with explosions in the new crater and steady growth of a cinder cone while hardened lava blocks were pushed out from the foot of the cone through the heavy pile of cinder. The explosion vents of the new crater were horizontally only about 10 m distant and vertically about 110 m above the lava spring vents. Although the upper and the lower vents are apparently connected in some way, explosive activity occurs only in the upper vents.—*M. C. R.*

13181. Westerveld, J. Vergeten berichten over Krakatau [Forgotten information about Krakatoa]: Nederlandsch Aardrijksk. Genootschap Amsterdam Tijdschr., Deel 68, no. 2, pp. 129–131, 1951.

Krakatoa is supposed to have become inactive in 1681 and to have remained in that state until 1883, when a severe eruption took place. Attention is called to the communication of F. Epp in his book "Schilderungen aus Ostindiens Archipel" covering a visit to the island in 1839, in which two fumaroles were noticed on the slopes of the volcano, which evidently was active at this date.—*S. T. V.*

TECTONOPHYSICS

13182. Eardley, A. J. Structural geology of North America, 621 pp., New York, Harper Bros., 1951.

This massive volume covers the structural geology of the entire continent and its associated islands. After a general summary of the continent's tectonic history, it proceeds to detailed descriptions of individual provinces which feature a vast number of maps and sections.—*D. F. B.*

13183. Wilson, J. Tuzo. Earthquakes, mountains, and their origin: Royal Canadian Inst., Proc., ser. 3A, v. 16, Session 1950–51, pp. 52–53, 1951.

This is an abstract of a lecture in the series of popular scientific lectures at Convocation Hall, University of Toronto, during the 1950–51 season. Island arcs, origins of mountains, processes of erosion and release of energy from within the earth are briefly outlined.—*L. E. B.*

13184. Rich, J. L. Origin of compressional mountains and associated phenomena: Geol. Soc. America Bull., v. 62, no. 10, pp. 1179–1222, 1951.

Compressional mountains of the Appalachian type reveal a pattern and a cycle of events so consistent as to suggest strongly a common genesis.

The cycle starts with the upwarping of a relatively large area which, if above sea level, is accompanied by a downwarp around its margins—a geosyncline—which serves as a catchment basin for sediments. After a considerable time, crustal movement off the upwarp causes thrusting and crumpling at its margins, overriding and folding any sedimentary rocks along the side of the geosyncline nearest the upwarp. After halts enduring for perhaps a geologic period, thrusting is repeated one or more times from the same direction. Compelling evidence indicates the presence of magma beneath the upwarped area.

Such a succession of events occurring in a definite order cannot be fortuitous It demands a common cause for mountain systems of the compressional type.

A mechanism which seems best to explain the events and sequences of the cycle is as follows: Atomic heating expands the crust and subcrust and melts a portion of the crust within a limited area, causing a domed regional uplift on a foundation of molten material having no permanent strength. Erosion of the uplifted area causes isostatic transfer, initiating an adjacent downwarp whose sinking is accentuated as it is filled with sediment. The crust creeps slowly down the slopes of the dome, and eventually thrust-faults toward the downwarp and folds its sedimentary rocks. Repeated movements occur, but finally crustal sliding off the dome causes tension and block-faulting in its central parts and copious emission

of lavas and escape of heat. After this final orogenic spasm, the lateral creep of the crust ceases and the upwarped area subsides as the magma beneath it cools and congeals.—*Authors' abstract*

13185. Moret, Léon. Les idées nouvelles sur l'origine des chaines de montagnes. [Recent concepts on the origin of mountain chains]: Grenoble Univ. Lab. géologie, Travaux., tome 28, pp. 1–56, 1951.

This is a review of different theories on the origin of tectonic movements in the crust of the earth. The article contains many examples and illustrations from different parts of the world, but the greatest attention is concentrated on the tectonics of the Alps, especially their western portion.—*S. T. V.*

13186. Vening Meinesz, F. A. A remarkable feature of the earth's topography, origin of continents and oceans. Parts I and II: K. Nederland. Akad. Wetensch. Proc., v. 53B, no. 3, pp. 212–228, 1951.

The investigation of the development in spherical haromonics of the Earth's topography by Prey shows that the first six terms are large; they practically dominate the great features, the distribution of the continents and the oceans, which appears to be founded on a mathematical base. The same is true for the variability in thickness of the sialic layer.

The large first order term is probably caused by the moon's birth from the Earth while the wave of great terms from the 2nd to the 6th order can be perhaps explained by a system of currents in the mantle; this might possibly have been connected with the commotion in the Earth when it resumed its equilibrium figure after the release of the moon or it may have occurred in a slightly later phase as a consequence of temperature disturbances; we thus arrive at a hypothesis about the origin of continents and oceans closely approaching that of Osmond Fisher, Jeffreys and Escher.

The higher order terms show two further waves of prominent values, the 8th to 11th order and the 12th to 16th order terms which each point to some physical phenomenon behind it. Possibly they were likewise caused by currents in the mantle but of a smaller size than the first mentioned system.—*Author's Summary.*

13187. Lûstikh, E. N. The problem of energy balance of the earth as the test of different geotectonic hypotheses [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 3, pp. 1–8, 1951.

It is known that the earth loses from its surface into interplanetary space a certain amount of heat. On the other hand, some heat is generated inside the earth by radioactive disintegration, seismic activity, pressure-induced density changes, and similar phenomena. Using hypothetical and to some extent doubtful data on mechanical and thermal processes in the crust and in the core, the author concludes that the hypothesis of contraction of the earth is untenable, and that the amount of heat generated inside of the earth exceeds heat losses from its surface.—*S. T. V.*

INTERNAL CONSTITUTION

13188. Gutenberg, Beno, Editor. Internal constitution of the earth, 439 pp.; New York, Dover Pub., Inc., 1951.

This is the second and revised edition of this work, originally published as Volume VII of the Physics of the Earth by the National Research Council. Obsolete data have been revised and new material has been added without increasing the size. Contributors of the volume, in addition to the editor, are

L. H. Adams, Hugo Benioff, R. A. Daly, F. W. Darling, Harold Jeffreys, W. D. Lambert, J. B. Macelwane, C. F. Richter, C. E. Van Orstrand, and H. S. Washington.—*M. C. R.*

13189. Beloussov, V. V. Problems of the internal structure of the earth and its evolution [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, pp. 3–19, 1951.

Fundamental phenomena established by the findings of modern geotectonics are the existence of slow vertical movements of oscillatory nature taking place in the crust of the earth and the importance of related subcrustal magmatic processes. These vertical movements of the crust have very small velocities, ranging from fractions of millimeters to few centimeters per year, although the total amplitude of such displacements has amounted to 15–20 km in certain regions.

The important feature of these oscillations is their variability. They are now and were still more in past geologic periods exceedingly complicated, varying in direction and intensity. They have resulted in the elevation of whole continents, as well as thousands of local changes of level resulting in the formation of geosynclines, faults, grabens. At one time in geologic history the entire surface of the earth was covered with ripples caused by subcrustal movements. This was the geosynclinal period of the evolution of the earth, followed by the transitory period with simultaneous existence of synclines and platforms, produced by stretching out of synclines into plane surfaces. Eight centers of the formation of such platforms, equally distributed over the northern and southern hemispheres, can be pointed out. The reverse process of transformation of platforms into geosynclines has occurred in certain regions, but it has been of a localized and less pronounced character.

Tectonic processes in the continents were the same as over oceans. Alpine geosynclines and platforms can be traced to the ocean depths, the only difference being that the tectonic outline has been preserved on the ocean bottom while erosion and sedimentation have produced great changes on the continents. As an example is cited the middle Atlantic ridge, which is an alpine geosyncline with still-volcanically-active Iceland on one end and two platforms on either side, the platforms being a continuation of the platforms of the European, American, and African continents. Similar conditions are found in the middle ridge of the Indian Ocean.

Some non-Russian authors are included in the bibliography, but in the paper itself, the work of scientists of the non-Russian world is not mentioned.—*S. T. V.*

13190. Jeffreys, Harold, and Bland, M. E. M. The instability of a fluid sphere heated from within: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 3, pp. 148–158, 1951.

G. F. S. Hills has suggested an explanation of the distribution of continents based on the experimental discovery of H. Bénard of cellular convection in a thin horizontal layer of liquid as the temperature decreases upward. Instability arises when the temperature gradient exceeds the adiabatic temperature by some value. This is applied for the first time to the case of a spherical earth. The appropriate differential equations are solved subject to the boundary conditons that the surface temperature of the assumed sphere is constant and that the surface is free. To discuss convection currents in the core a well-conducting rigid boundary is assumed. It is found that the easiest modes to excite are those in which the disturbances of temperature and radial velocity contain spher-

ical harmonics of degree one. The surface currents would tend to sweep the floating matter to one side. This is a possible explanation of the distribution of land and water hemispheres. This development does not consider the magnitude of surface relief that could be produced.—*I. Z.*

EXPLORATION GEOPHYSICS

GENERAL

13191. García Siñeriz, José. Memoria General 1948: Inst. geol. min. España, 88 pp., 1949.

Chapter 5 contains a list and brief description of geophysical and hydrologic investigations in different sections of Spain. These reports are accompanied by profiles and geologic maps of the investigated areas.—*L. E. B.*

13192. García Siñeriz, José. Memoria General 1949: Inst. geol. min. España, 89 pp., 1950.

Section 3 contains a list and brief description of the continuation of projects previously reported (1948) and of similar new projects begun during 1949.—*L. E. B.*

13193. Union of South Africa Department of Mines. Annual report, including reports of the Government Mining Engineer and the Geological Survey for the year ending 1949, pt. 3, Sec. 5—Underground Water and Geophysics Branch: U. G. no. 53, pp. 135–139, 1950.

Included in the report is a summary of the work of the Underground Water and Geophysics Branch. A relationship between the electrical resistivity of weathered rocks and their water-yielding properties, in a specified area has been established and the factors governing the presence or absence of underground water in a large part of the country have been determined.

Other geophysical methods used were the electromagnetic (to determine narrow zones of weathering), seismic (to determine configuration of artesian basins), magnetic (to trace Karroo dolerites), and regional gravimetric surveys. Three long-period Benioff seismographs have been installed in Pretoria, Maritzburg, [Pietermaritzburg], and Grahamstown, and a fourth will be installed at Kimberley.—*L. E. B.*

13194. Uganda Protectorate, Geological Survey. Summary of progress for the years 1929 to 1949 with appendix of analyses of rocks and minerals from Uganda and graphs of mineral output, 107 pp., Uxbridge, England, King and Hutchings, Ltd., 1949.

The report includes a brief summary of work in the geophysical exploration since 1937. Electrical, gravity, magnetic, and radioactive surveys have been made. Electromagnetic work is being considered. The Seismological Observatory at Entebbe has been transferred to the Meteorological Department.—*L. E. B.*

13195. Ver Wiebe, W. A. How oil is found, 247 pp., Ann Arbor, Mich., Edwards Bros., Inc., 1951.

Chapter 8 of this book deals briefly with geophysical methods, equipment, and interpretation of data for oil prospecting. Discussions of well logging, magnetic, seismic, gravity, aeromagnetic, and electromagnetic methods, as well as other techniques such as geochemistry and soil analysis, are discussed.—*L. E. B.*

13196. Evrard, Pierre. Les méthodes géophysiques appliquées a la prospection du pétrole [Geophysical methods used in petroleum exploration]: Rev. univ. mines, 9th ser., tome 7, no. 10, pp. 354–362, 1951.

Structures favorable to the accumulation of petroleum and the principles of magnetic, gravimetric, and seismic methods of determining them are reviewed.—*M. C. R.*

13197. Gubler, Y. Méthodes de reconnaissance pétrolifère des bassins sedimentataires [Methods of petroleum exploration of sedimentary basins]: Rev. univ. mines, 9th ser., tome 7, no. 10, pp. 348–354, 1951.

The importance of geology in the discovery of new fields does not need demonstration. Surface observations should be supplemented by indirect methods including geophysics, and electrical and radioactivity logging.—*M. C. R.*

13198. Bichau, W. J. Oil prospecting—the tectonic approach: Oil in Canada, v. 3, no. 48, pp. 14–18; no. 49, pp. 16–19; no. 52, pp. 28–31, 1951.

A thorough, detailed study of pre-Cambrian tectonics is recommended as a guide for the discovery of oil accumulations in the overlying Paleozoic and Mesozoic formations of western Canada. Interpretation of existing geophysical data and aerial photographs provides abundant material for determining the tectonics of the pre-Cambrian, which is obviously related to that exposed in the adjacent Canadian shield. These rocks are seldom covered by more than 10,000 ft of sediments, and later faulting may be guided by lines of weakness within the pre-Cambrian. The tectonics control the physiography of the pre-Cambrian erosion surface, the irregularities of which are reflected both in the attitude of the sediments, such as closures produced by differential compaction over a ridge, and in the sedimentation, for example, in the pinching out of sands on steep slopes, and the growth of reefs on platforms. Two possible alinements of oil fields may be distinguished, one along the strike, and the other paralleling the main direction of late faulting in the pre-Cambrian shield.—*E. K.*

13199. Cloninger, J. S. How deep oil or gas may be expected: World Oil, v. 130, no. 6, pp. 57–62, 1950.

The maximum depth depends on the depth to which openings may exist in sedimentary rock, the depth to which favorable sedimentary rocks may occur, and the depth to which oil and gas can be expected to exist if favorable rocks are present. From a study of experimental evidence on such factors as compressibility, crushing strength, temperature and pressure, and solubility of the chief reservoir rocks, sandstone and limestone, it is concluded that theoretically oil or gas may occur in sandstones to a depth of 65,620 ft and in limestones to 51,300 ft.—*M. C. R.*

13200. Oil in Canada. Western Canada operation—1951 style: v. 3, no. 46, pp. 56–57, 1951.

New dual-season equipment has revolutionized geophysical operations in Canada. These improvements include the "Weasel" vehicles for muskeg operations, Bombardier trucks with rubber tracks, trailer camps for improved living conditions, portable seismic instruments or "suitcase" method, and helicopter and air transport.—*L. E. B.*

13201. Bödvarsson, Gunnar. Geofysiske metoder ved varmtvandsprospektering i Island [Geophysical methods of prospecting for hot water in Iceland]: Tímarit verkfraeding afélags íslands, no. 5, 11 pp., 1950.

Artesian hot water and steam from boreholes are used extensively in Iceland for heating buildings. About 600 liters of water per second with an average temperature of 87° C is thus used, and the production of steam is about 70 [metric] tons per hour. Most of the boreholes are near hot springs.

Geophysical [and related] methods are now used to aid in developing additional sources of water, especially at greater depths. These methods are magnetic, thermal and chemical, electrical resistivity, and hydrological.

Magnetic surveys in connection with structural studies have been useful in locating alluvium-covered basalt dikes in basalt flows. The dikes, which are aquifers by virtue of their higher permeability, give rise to large magnetic anomalies.

Temperature measurements in springs and wells give information on the volume and source of hot water, inasmuch as the temperature is proportional to the volume of water available. The silica content, on the other hand, is in inverse proportion to the volume of water.

Electrical resistivity surveys have been used since 1947 to outline areas of low bedrock resistivity, which are in general indicative of underlying hot water because the mineral content and hence the conductivity of the water increases with temperature.

Systematic measurements of artesian pressure in boreholes permit estimating the hydrologic possibilities in thermal areas and thereby determining the point at which additional drilling becomes uneconomic.

Steam occurrences are found in areas where volcanic basement is overlain by Quaternary tuff and sediments as much as 400 m thick. Geologic studies and prospect drilling have been more useful than geophysical measurements in developing these occurrences, because of their large areal extent and recognizable structural control.—*H. R. J.*

GRAVITY METHODS

13202. Falcon, N. L., and Tarrant, L. H. The gravitational and magnetic exploration of parts of the Mesozoic covered areas of south-central England, Part II: Geol. Soc. London Quart. Jour., v. 16, pt. 2, no. 422, pp. 141–170, 1951.

This paper describes gravity meter and magnetometer surveys made during 1945 to 1949 of some 6,000 square miles of southern England. The problem was to select areas where the Paleozoic floor underlying the Mesozoic rocks are most likely to consist of a considerable thickness of upper Carboniferous rocks, preferably overlying lower Carboniferous rocks; and within those areas to locate and map anticlinal folds in the Carboniferous rocks. If a considerable thickness of Carboniferous rocks exists, including anticlinal structures containing porous rocks protected by adequate cover rocks, there would be a reasonable prospect for oil discovery.

A total of 13,300 gravity stations and 2,900 magnetic stations were observed. The accuracy of gravity stations is expressed as a standard error of about ± 0.05 mgal; and the relative accuracy of the anomalies varies from ± 0.1 mgal in the flatter parts of the area to ± 0.3 mgal in the more hilly parts. The gravity data are shown on a Bouguer anomaly map with a contour interval of 1 mgal. The magnetic measurements are accurate to about ± 5 gammas and are shown on a vertical intensity map with a contour interval of 20 gammas, corrected for terrestrial gradients.

To arrive at an expression of thickness of the Coal Measures from gravity data it was necessary to take into account the effects of both the relatively light overlying Mesozoic rocks and of the relatively dense underlying pre-Coal Measures rocks. The Mesozoic effect was determined empirically from density and gravity observations over known thicknesses of Mesozoic rocks directly overlying older Paleozoic rocks. The pre-Coal Measures rocks are considered as producing random variations about zero, of magnitude defined by a standard deviation of 3.8 mgals. On this basis a contour map of predicted Coal Measures thickness was prepared. Deficiencies of gravity on this map represent comparatively thick Coal Measures sections. The predicted thickness is subject to a standard error of 2,000 ft, mainly owing to unpredictable variations in the pre-Coal Measures rocks.

Also presented is a map showing trends of residual gravity highs, obtained by subtracting a regional gradient from the Bouguer anomaly map. All significant known anticlines are represented by these trends. Anomalies not correlated with surface structure are considered to be caused by structures in the underlying Paleozoic rocks.

The magnetic and gravity maps are in general agreement. Depth estimates based on magnetic data indicate no great interval between the base of the Mesozoic and the top of the igneous rocks in areas of strong, localized magnetic highs, which are also areas of gravity highs. The magnetic data further suggest that the basement rocks were involved in the Paleozoic structures.

It is concluded that appreciable thickness of Upper Carboniferous rocks may be present under considerable areas of the Mesozoic regions in south-central England, and that the major residual gravity highs represent actual geologic structures.

Preliminary seismic results support the gravity interpretation given in this paper.—*H. R. J.*

MAGNETIC METHODS

13203. Bath, G. D. Magnetic base stations in Lake Superior iron districts: U. S. Bur. Mines Rept. Inv. 4804, 16 pp., 1951.

Magnetic base stations in groups of four to six were established in six areas in the large iron-mining districts of Minnesota, Michigan, and Wisconsin during the summer of 1946. Differences in magnetic intensity between stations and between each area and a magnetic datum at Cheltenham were measured with a modified Askania magnetometer. Magnetic data, locations of stations, and Brunton compass-and-tape survey data are given in figures and tables.—*M. C. R.*

13204. Prest, V. K. Geology of the Keith-Muskego townships area: Ontario Dept. Mines Rept., v. 59, pt. 7, 44 pp., 1950.

As a result of a promising discovery of gold in Keith township, district of Sudbury, in June 1946, a detailed geological survey of part of the area was undertaken. A magnetometer survey was carried out over part of the properties of Joburke and Garnet gold mines. The magnetic work was undertaken in an effort to trace certain key horizons and thereby gather important structural information. It was not successful in tracing rhyolites or in tracing fault structures because of lack of magnetic contrast. Some success was obtained in tracing the iron formation. The most interesting anomaly was found in the central part of the Garnet property, trending at a small angle across the strike and schistosity. Diamond drilling showed the anomaly to be due to a biotite lamprophyre less than 20 ft wide. A magnetic contour map of the Joburke area is included.—*M. C. R.*

13205. Whetton, J. T., and Myers, J. O., Geophysical survey of a magnetite deposit in the Island of Tiree: Geol. Soc. Glasgow Trans., v. 21, pt. 2 (1947–49), pp. 237–262, 1951.

A Thalen Tibery Magnetometer was used in making 34 east-west vertical-magnetic-force traverses across a magnetite-rich, garnet-biotite paragneiss striking approximately north-south on the island of Tiree, Scotland. Where exposed the magnetite occurs as a band 13 ft wide, with the middle portion nearly pure magnetite. Observations at 100-ft stations along the profiles showed anomalies as large as 5000 gammas but a single band of magnetite-rich gneiss apparently does not continue across the island and there is no concentrated band of magnetite which would make ore.

Seven other traverses were run elsewhere on the island to investigate the magnetite content of other bands of paragneiss. No significant anomalies were found. The data are presented on maps and profiles together with a discussion of each profile.—*W. J. D.*

13206. Canada Geological Survey. Ground magnetic survey map of the Province of Quebec, Abitibi County. Scale 1 inch=1,000 feet, contour interval=100, 500 or 1,000 gammas: Dept. of Mines and Resources, Mines, Forests and Sci. Services Branch, 1948.

Geophysics Paper 2 is a magnetic map of Bourlamaque quadrangle, Abitibi County, Province of Quebec. The magnetic information on these four sections of the blue line map was supplied through the courtesy of the individual property owners and compiled by George Shaw and D. MacCallum. These areas have been geologically mapped on the same scale (1 in.=1,000 ft). An attempt has been made to reduce all surveys to a common magnetic base, but individual surveys have not otherwise been changed.—*L. E. B.*

13207. Vacquier, Victor V., Steenland, N. C., Henderson, R. G., and Zietz, Isidore. Interpretation of aeromagnetic maps: Geol. Soc. America Mem. 47, 151 pp., 1951.

The study of magnetic anomalies that originate from large-scale differences within the basement complex can reveal the large-scale structural pattern of the magnetic rock mantle, the maximum depth to its upper surface, and a rough figure for the depth at which rocks cease to be magnetic. The magnetic anomalies can be assumed to be produced, in the northern hemisphere, by south-seeking magnetic poles distributed over the top surface of a mass of magnetic material and by north-seeking poles over the bottom. Since the intensity of the anomaly at the point of measurement is proportional to the difference of the solid angles subtended by the top and bottom surfaces of the mass, the anomaly will be greatest when the mass is deepest and will have steepest sides when the top of the mass is nearest the level of measurement. If the sides of the mass are not vertical, the sharpness of the anomaly will be decreased. Thus the sharpness of magnetic anomalies is a measure of the maximum possible depth to the upper surface of the polarization contrasts.

The method of interpretation of magnetic surveys consists of comparing observed anomalies with the computed magnetic effects of idealized bodies. The models in this report are bottomless rectangular prisms with vertical sides having uniform polarization and a polarization vector in the direction of the present earth's field. Since most magnetic anomalies arise from the lithology and not from the topography of the basement rock, the interpretation of magnetic anomalies in terms of topographic relief of a homogeneous basement has not been considered.

The total anomalous magnetic intensity due to a prism is the surface integral of the product of two functions of position, the polarization I (α, β), and an irrational algebraic function U (α, β, δ) and can be written

$$\triangle T = \int\int I(\alpha, \beta)\, V(\alpha, \beta, \delta) d\alpha d\beta$$

where α and β are respectively the north and east coordinates on a plane containing the upper surface of the prism, and δ the complement of the dip angle which is assumed constant over the area of any one map. This integral can be evaluated approximately by dividing the α, β plane into small squares, estimating the average values of the functions I and U for each square and summing up the individual products. If the polarization is uniform, as is assumed in this report, the I function is a constant and the anomaly can be determined from a summation of the U function alone. The U function has been derived in terms of α, β, and δ. The values of the function at coordinate intersections and the average values at the centers of the coordinate squares have been computed and tabulated for specific values of the inclination. Contour maps of total magnetic intensity produced by any rectangular prisms can be quickly prepared by using these tables. This report includes maps of the total anomalous magnetic intensity of 6 to 9 rectangular prismatic models at seven inclinations and of fifteen special models. The cross-sectional dimensions of the prisms are in units of the depth of burial of the upper surface. These charts also show the second vertical derivative or curvature of the total anomalous magnetic intensity. There has also been derived the expresssion for the total anomalous magnetic intensity produced by a thin plate, but none of the values have been computed.

The zero contour of the second derivative map tends to outline the top surface of the magnetic anomaly so the second derivative map is most useful for choosing the appropriate model. Since the steepest gradients are caused by the shallowest and steepest contacts these are measured on both maps and are used to determine the depth to the source of the anomaly. Various standard profiles have been chosen on the models and their "depth indices" determined. These depth indices vary with the size and shape of the model and the inclination of the magnetic field, but certain ones that have a wide range of reasonably constant value can be used to make a preliminary check on the proper choice of the model. The magnetic susceptibility contrast is the amplitude of the observed anomaly divided by the product of the intensity of the earth's main field and the amplitude of the anomaly of the model chosen.

The usefulness and accuracy of the charts and of this method of interpretation are demonstrated by six examples: Worcester County, Md.; Appalachian Plateau, central Pennsylvania; Mangum, Okla.; Bagdad, Ariz.; and northeastern Umnak and northern Adak Islands, Alaska. The general geology of each area is presented and used to interpret some of the magnetic anomalies in terms of geologic units. A second derivative map has been prepared from each total intensity map and features of the two maps are compared with the computed anomalies of models. A suitable model is chosen and the depths are computed. The computed depths are compared with actual depths where they are known and where these data are not available, the depths computed from the two different levels or from the intensity and second derivative maps are compared. The mean error of the depths computed from the intensity map are 6 percent for Bagdad, 12 percent for Umnak, and 3 percent for Adak; those computed from the second derivative maps are 1 percent for Bagdad, 20 percent for Umnak, and 10 percent for Adak.—*J. R. B.*

13208. Harding, W. D. Preliminary report on ground investigation of aeromagnetic anomalies of the Campbellford and Bannockburn sheets: Ontario Dept. Mines Rept., v. 7, no. 6, 8 pp., 1951.

Dip needle and geologic investigations have been made in part of the area covered by an aeromagnetic survey described in a similar Ontario Department of Mines Report on the Bancroft and Coe Hill sheets (Geophys. Abstract 12818) to which this report is an addendum. The magnetic anomalies are attributed to magnetite, and one near Marmora has been found, by drilling, to be caused by a magnetite ore body covered by 100 to 700 ft of Ordovician limestone. A tabular summary is given of 43 magnetic anomalies examined with descriptions of terrain, geology, aeromagnetic anomaly, dip needle results, and cause of the anomaly.

It was found that the aeromagnetic survey was valuable as a means of discovering magnetite ore bodies and of mapping areas of magnetite-rich rocks. The flat-lying Paleozoic rocks may be magnetically ignored and in this district pyrrhotite is a minor factor in producing anomalies. Dip needle surveys of an aeromagnetic anomaly generally show that the ground feature has different shape, direction of elongation, and other characteristics than measured at altitude. However, even the most intensive ground surveys require mining work to dissipate speculation.—*J. R. B.*

13209. Sans Huelin, Guillermo. Prospección magnetica desde el aire [Airborne magnetic prospecting]: Rev. Geofis., v. 10, no. 38, pp. 140–142, 1951.

The development of airborne magnetic surveying through the efforts of American and Canadian geophysicists is reviewed. Instrumental equipment and procedures are described. Possible future developments of the method, as for instance, in the search for oil and for nonmagnetic minerals and especially when combined with aerial photography, are discussed.—*S. T. V.*

13210. Lundbak, Asger. Aeromagnetic survey of vertical intensity over the Sound with apparatus of the BMZ type: Tellus, v. 3, no. 2, pp. 69–74, 1951.

A BMZ (magnetic zero balance) magnetometer mounted in gimbals in an airplane having a wooden air frame was used to make vertical intensity measurements at 500 m and 4000 m above the Sound, between Denmark and Sweden. Five east-west traverses and one north-south traverse were made.

Corrections for lack of verticality as determined by reading a spirit level and for the permanent magnetization of the aircraft engines were made. Periodic clamping of the balancing magnet minimized errors due to vibration. Corrections for time variation were made by use of the Rude SKOV observatory records and the measurements adjusted to Rude SKOV absolute determination at January 1, 1949. An accuracy of from 50 to 100 gammas for various traverses is estimated. The data are presented on maps and profiles and a comparison of airborne and ground magnetic measurements shows agreement in all essentials.—*W. J. D.*

13211. Canada Geological Survey. Aeromagnetic map of Province of New Brunswick, Scale 1 inch=1 mile, contour interval=10, 20, 100, and 500 gammas, depending on the intensity of the anomaly. Dept. Mines and Tech. Surveys, 1951.

Geophysics Paper 66 is an aeromagnetic map of California Lake quadrangle, Northumberland, Gloucester and Resigouche Counties, New Brunswick. The

total magnetic intensity at about 500 ft above ground level is shown by contour lines on this blue line map.—*L. E. B.*

13212. Canada Geological Survey. Aeromagnetic map of Northwest Territories. Scale 1 inch=1 mile, contour interval=10, 20, 100, and 500 gammas, depending on the intensity of the anomaly: Dept. Mines and Tech. Surveys, 1951.

Geophysics Paper 52 is an aeromagnetic map of Hornby Channel quadrangle, in the District of Mackenzie, Northwest Territories, Canada. The total magnetic intensity at about 1000 ft above ground level is shown by contour lines on this blue line map.—*L. E. B.*

13213. Canada Geological Survey. Preliminary aeromagnetic maps of Province of Quebec. Scale 1 inch=1 mile, contour interval=10, 20, 100, and 500 gammas depending on the intensity of the anomaly: Dept. Mines and Tech. Surveys, 1950.

Geophysics Paper 19, Kinojevis, Temiscamingue and Abitibi Counties, Province of Quebec, shows the total magnetic intensity at about 1,000 ft above ground level by means of contour lines on a blue line map.—*L. E. B.*

SEISMIC METHODS

13214. Coote, G. F. The seismic operation: Oil in Canada, v. 3, no. 46, pp. 26–27, 1951.

This is a description, accompanying a schematic diagram, of the reflection method of seismic prospecting.—*L. E. B.*

13215. Green, C. H. Relationship of research and field operations in seismic exploration: Oil in Canada, v. 3, no. 46, pp. 50–54, 1951.

This is a condensation of the article in the Colorado School of Mines Quarterly, abstracted as Geophys. Abstract 12019.—*L. E B.*

13216. Moore, C. M. How a seismic crew does the job: Oil in Canada, v. 3, no. 46, pp. 28–29, 1951.

In nontechnical language a brief description is given of the equipment, usually 5 trucks, and the duties of the 15 man crew, working in 2 sections, that compose the seismograph crew. Principles of the reflection method are briefly and simply explained.—*L. E. B.*

13217. Weiss, Oscar. Problems of seismic work on Canadian coral reefs: Oil in Canada, v. 3, no. 46, pp. 34–36, 1951.

This is a reprint of the article (published in Oil in Canada, v. 3, no. 26, pp. 16–27, 1951) and abstracted in Geophys. Abstract 12823. A diagrammatic cross section through the sediments of Alberta has been added.—*L. E. B.*

13218. Riznichenko, ЮV. V., Ivakin, B. N., and Bugrov, V. R. Modeling of seismic waves [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 5, pp. 1–30, 1951.

Different possibilities of studying seismic phenomena by models are discussed, and related investigations made since 1944 in the Geophysical Institute of the Akademiâ Nauk SSSR are described. Use of lattice models of discrete properties as well as hydraulic models utilizing ripples on the surface of fluid (water, mercury

and others), was found unsatisfactory. More promising is optical observation with cinematographic recording of waves excited in gaseous, liquid, or transparent solid media. The so-called oscillographic method is considered the most powerful. In this the behavior of different component parts of the studied medium is observed and recorded by devices similar to familiar geophones, connected to special oscillographs. The waves in the model are produced piezoelectrically and can be of many kinds and of different spectra. The selection of the source exciting the waves must be made in accordance with the evidence obtained in seismological observations and with the assumed form of the initial impulse in the focus of the earthquake.

A detailed description is given of experimental installations used in the studies with the analysis of elements employed for the production and observation of the waves. The final picture obtained from the model, using a number of oscillographs, is similar to the seismic record obtained from multichannel seismograph in the field during seismic exploration.

The scales of the phenomena observed in the field and on the model are analyzed and conditions to be fulfilled for the fidelity of the records on the model are discussed.

An extensive bibliography is included.—*S. T. V.*

13219. Berson, I. S. Determination from experimental data of the power exponent of the function representing the spreading of refracted waves [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, pp. 1–30, 1951.

If a seismic wave coming from a medium of lower velocity of propagation is incident at less than grazing angle on a formation of higher velocity, then in addition to the reflected wave and the refracted wave propagating along the boundary, a third wave, called the "sliding wave", will be formed in the higher-velocity medium along its path. The amplitude of this wave will decrease because of the involvement of an ever increasing number of particles in the vibration, so that the energy density decreases at points further from the source of vibration and because the energy of vibrations is absorbed owing to the incomplete elasticity of the medium as well as to repeated reflections, producing energy radiation downward into the ground. The amplitude A of the wave in different points of the medium can be assumed to vary according to the formula $A = C_{f(x)} \cdot e^{-(\alpha_1 r_1 + \alpha_2 r_2)}$ where C is a constant, x the distance from the source of vibrations, α_1, and α_2 are the coefficients of absorption in the upper and lower media, r_1 and r_2 are the lengths of advance of the sliding and refracted waves and $f_{(x)}$ is the function which determines the decrease of the amplitudes by spreading of the area of vibrations. Following Muskat, Brekhovskikh and others, $f_{(x)}$ is assumed to be an exponential function of the simplest form x^n.

A detailed discussion of the graphoanalytical method of the determination n is presented, and the method is applied to available experimental data. From these data the amplitude curve, the relation between A and x is first derived. This is presented in the form $\log A = \psi(x)$, $\psi(x)$ being the unknown. There are several possibilities of determining the shape of $\psi(x)$, the most convenient and accurate being that using the amplitude curves of waves propagating in the same direction. The values of n determined from different sets of observations under different geologic conditions ranged from 1.5 to 2.0, although some greater and smaller values were also found.

It is evident than n is a function of the depth and the thickness of refracting formation, that it is influenced by the ratio of the velocities in the overburden and in the refracting medium, and that it is a function of the principal frequency of the wave spectrum. The determination of n is the first step in finding the

coefficients of absorption of different geologic formations. Knowledge of n and of α_1 and α_2 will increase the usefulness of the seismic method of exploration.—*S. T. V.*

13220. Vasil'ev, Ю. V. Determination of the absorption coefficient of seismic waves [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 4, pp. 31–42, 1951.

Seismic methods of exploration now in use are based on differences in the velocities of propagation of elastic waves through different layers. The author hopes to have introduced a second characteristic parameter of geologic formations and thus to increase the power of seismic method of exploration. A method is given for finding from experimental data the coefficients of absorption of elastic waves in different layers. Graphoanalytical methods are developed for finding the coefficients of absorption in the refracting formation and in the overburden. The suggested methods were then applied to experimental data obtained in several surveys. The agreement between the experimental and computed results was not always satisfactory, which could many times be attributed to such factors as curvature of the boundary, an inappropriate selection of the value of n (*see* preceding abstract), or to resonance phenomena, but many values were fully reliable.—*S. T. V.*

13221. Burg, K. E., Ewing, Maurice, Press, Frank, and Stulken, E. J. A seismic wave guide phenomenon: Geophysics, v. 16, no. 4, pp. 594–612, 1951.

On one particular prospect in shallow water repetitive patterns appeared on short spread seismograms in such prevalence as to jeopardize identification of desired reflections. It is demonstrated that under favorable conditions, less restrictive than thought necessary heretofore, a layer of water comprises an effective wave guide for seismic energy propagation. Reinforcement fronts formed by multiple reflection of sound in water can develop into a set of waves completely overshadowing other seismic arrivals. With but minor modifications conventional wave guide theory applies.

Examples from the prospect are presented to illustrate various reinforcement patterns. Observed frequency characteristics, group velocity, and phase velocity magnitudes are investigated for normal modes of propagation.—*Authors' abstract.*

13222. Epinat'eva, A. M. Secondary pressure-bubble pulses in seismic exploration [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 4, pp. 43–60, 1951.

During seismic exploration over water-covered areas quite often an underwater explosion is followed by one or more secondary pulses which greatly complicate seismograms. These pulses occur because the gas bubble formed by the products of explosion expands until the pressure in the bubble drops below that of the surrounding water, and then contracts so that the pressure becomes very high, and a new sound wave is emitted on the subsequent expansion. Numerous experiments have been made to determine conditions necessary to avoid secondary pulses. Shots were produced with different kinds of explosives in amounts ranging from very small charges to more than 100 kg. Experiments were carried out in different reservoirs to test the influence of various boundary conditions. The depth of explosions ranged from 1 to 15m. Records of the explosion and secondary pulses were made by multichannel seismographs, placed at different distances from the shot point. Experiments will be continued, but the follow-

ing preliminary findings are presented: the ratio of the secondary amplitude, A_2, to that of the first, A_1, may be greater than one, for small charges of less than 300 g, and may sometimes be as high as 3.3; with charges greater than one kg, A_2/A_1 is usually less than one, decreasing with every following pulse; secondary pulses are improbable when $Q=(h+30)/38.h^3$, Q being the amount of explosive in kilograms and h the depth of the shot.—*S. T.V.*

13223. Ricker, Norman, and Sorge, W. A. The primary seismic disturbance in shale: Seismol. Soc. America Bull., v. 41, no. 3, pp. 191–204, 1951.

Studies for the purpose of determining the form and laws of propagation of the primary seismic disturbance were made in the Pierre shale of eastern Colorado where the shale is 4,000 or 5,000 ft thick. Three vertical-component geophones were placed in a drill hole at depths of 822, 622, and 422 ft and a horizontal component at 522 ft. Charges were fired at depths varying in steps of 25 ft throughout the length of 310-foot holes drilled at distances of 50 to 1,600 ft from the instrument hole. Results show that the disturbance broadens as the square root of the travel time, and the law of decay of amplitude of earth-particle velocity is reasonably close to the $-5/2$ power of the travel time. The "seismic punch," which is the earth-particle velocity for a travel time of 1,000 milliseconds, is very low for shallow shots, and increases as the shot is placed deeper, reaching a maximum for shot depths of about 100 ft. For the mathematical theory of the propagation of these disturbances, *see* Geophys. Abstract 7297.—*M. C. R.*

13224. Dobrin, M. B., Simon, R. F., and Lawrence, P. L. Rayleigh waves from small explosions: Am. Geophys. Union Trans., v. 32, no. 6, pp. 822–832, 1951.

Extensive field studies of surface waves generated by explosions such as those used in seismic prospecting have been made by an experimental seismic crew of the Magnolia Petroleum Co. Records were made by vertical and horizontal geophones through a system with flat response from 5 to 200 cycles per second. Shots were exploded in boreholes 40 ft or more deep and also 8 ft in the air, and recorded along surface profiles and at depths to 100 ft in boreholes. Dispersion characteristics of Rayleigh waves recorded at the surface from hole shots can be explained as the effect of near-surface layering. Variations in shear velocity rather than in compressional velocity seem to control the dispersion. The variation of maximum Rayleigh-wave amplitude with increasing depth of explosion and the trajectories of particle motion show as good agreement with theory as can be expected, considering the simplifying assumptions made. Constant-frequency wave trains observed immediately after the air wave arrival on records of air shots have been identified as air-coupled waves.—*M. C. R.*

13225. Prescott, H. R. Seismic record sections: Geophysics, v. 16, no. 4, pp. 613–625, 1951.

A method is described whereby seismic records may be secured which have sufficient dimensional stability that a composite reprint of several records, from a continuous profile, when placed in proper sequence, yields a cross section of seismic arrivals. A method is described for entering corrected time scales on the seismic record section itself. Double recording is provided, with traces in transposed positions but alike in phase relation, which makes possible the construction of closed traverse sections. A few examples of the record section are shown and some uses suggested.—*Author's abstract.*

13226. Hayakawa, Masami. Outline of "Some problems of seismic prospecting": Geol. Survey Japan Bull., v. 1, no. 3, pp. 1–8, 1950.

The characteristics of the Haeno seismograph used by the Geological Survey of Japan is described in some detail, and the seismic records and their interpretation discussed briefly.—*M. C. R.*

13227. Süsstrunk, August. Seismische Gletscheruntersuchungen 1948–50 [Seismic exploration of glaciers 1948–50]: Schweizer naturf. Gessell. Verh, v. 130, pp. 151–158, 1950.

Sounding of glaciers is of fundamental importance when the eventual capacity of big hydroelectric installations erected high in the mountains is determined by the volume of glaciers feeding the turbines. Use of seismic methods initially met great difficulties because the complexity of the bottom configuration often caused unreadable seismograms. Use of modern instruments equipped with electrical geophones and suitable amplification has been more successful. Exploration by the seismic reflection method of an area of more than 12 sq km of glaciers in Valais and in other parts of Switzerland during 1948–50 produced good results. The error in the determination of the depth of ice as revealed by subsequent thermal drilling was never greater than ±5 percent. The thickness of the layer ranged from 80 to 500 m.—*S. T. V.*

13228. Tateishi, Tetsuo. Report on seismic prospecting near West Toyama: Geol. Survey Japan Bull., v. 1, no. 4, pp. 78–80, 1950.

From seismic surveys to investigate the subsurface geologic structure, it was found that the direction of strike is northwest, the central part of the area is a little higher than the lateral parts, indicating plateaulike configuration; and an anticlinal structure is surmised at the depth of 300–400 m below the surface.—*M. C. R.*

13229. Hayakawa, Masami, and Tateishi, Tetsuo. Seismic prospecting at Shimizusawa district in Ishikari coalfield, in Hokkaido [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 3, pp. 43–49, 1950.

Seismic refraction surveys were made in the Shimizusawa district in the southern part of Yūbari. Three layers of seismic wave velocities of 2.0–2.2 kmps, 2.9 kmps, and 3.5–3.8 kmps, from the surface downward, were recognized. The 2.0–2.2 kmps and 2.9 kmps layers correspond to the Poronai shale bed, and the 3.5–3.8 kmps layer to the Ishikari series. The depth of the boundary between upper and lower layer is shallower in the north than in the south. A fault is postulated.—*M. C. R.*

13230. Hayakawa, Masami, and Mori, Kiyoshi. Seismic prospecting on the seabottom near Sakito, Nagasaki prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 4, pp. 31–37, 1950.

Seismic refraction surveys to determine the boundary between granite and Tertiary formations on Sakito Island [Sakito-shima], show that there are three layers, in which the velocities are 1.65, 2.7–3.2, and 4.3–5.3 kmps, which may correspond to the Quarternary, Tertiary and granite, respectively. The boundary between granite and Tertiary zones trends approximately northwest-southeast and is deeper in the north than in the south.—*M. C. R.*

ELECTRICAL METHODS

13231. Wait, J. R. A conducting sphere in a time varying magnetic field: Geophysics, v. 16, no. 4, pp. 666–672, 1951.

The secondary magnetic fields of a conducting sphere embedded in a relatively poorly conducting medium under the influence of a time varying magnetic field are investigated. Applied fields of the sinusoidal and step function types are considered.

The total external steady-state field involves in phase and out of phase components which could be the basis of a geophysical method to ascertain the conductivity or radius of the embedded sphere. A local field could be set up by a suitable ungrounded wire loop, and the secondary fields obtained by receiving loops.

The calculations show that the conductivity or radius of the sphere could also be determined by measuring the magnetic field response following the application of step-function-type magnetic field. Although the conditions appear stringent, the solution would be satisfactory, for example, for a large massive sulfide body of conductivity 10^{-2} mhos per meter in a surrounding country rock of conductivity 10^{-3} mhos per meter.—*R. G. H.*

13232. Nomura, Yukichi. On the propagation of electric waves from a horizontal dipole over the surface of the earth sphere: Tōhoku Univ. Sci. Repts., Research Inst., ser. B, v. 1–2, no. 1, pp. 25–49, 1951.

The problem of propagation of electromagnetic waves generated by a horizontal magnetic or electric dipole located above the surface of a finitely conducting spherical earth is treated in much the same way as the problem of a vertical dipole. Lack of symmetry about the axis of the horizontal dipole, however, requires that consideration be given to all the spherical components of both the electric and the magnetic fields.

The total field at a point is regarded as the superposition of spherical waves originating at the center and at the surface of the sphere. All component waves which have travelled over a distance greater than twice the diameter are neglected. Formulas for the field in the shadow domain are obtained in terms of residues of contour integrals.

In the case of the horizontal electric dipole, the electric field has only a weak radial component and the magnetic field only a weak azimuthal component on the surface of the earth. For the horizontal magnetic dipole, however, the radial and azimuthal components of both the electric and magnetic fields are of considerable importance at large distances from the source.

In the lit region the derived series converged too slowly to permit calculations, hence an approximate expression was obtained by recourse to geometric-optical rays.—*R. G. H.*

13233. Alfano, Luigi. Studi sulla interpretazione dei sondaggi electrici verticali [Studies of the interpretation of the electrical resistivity curves obtained in vertical sounding]: Riv. Geofis. Appl., v. 12, no. 1, pp. 21–33, 1951.

In electrical vertical sounding the first step, obtaining the resistivity curves, is simple, but the interpretation is difficult, necessitating long calculations and seldom leading to conclusive results. Even in the simplest case of parallel horizontal strata the existing methods of Hummel, Ehrenberg and Watson, or Stefanescu lead to conclusions as to the tectonic properties of the explored area only after long summation of series (Hummel's method) or cumbersome evaluation of integrals (Stefanescu's procedure). A new graphoanalytical method of analysis of the

data is suggested. It gives the value of the apparent resistivity of a stratified terrain more accurately and with fewer difficulties than any known analytical methods. For constant resistivity of the ground, equations and formulas similar to those of Hummel are used. If the resistivity varies according to a certain law, the value of the potential energy propagating from the source is found by the formula of Stefanescu, using Bessel's functions of zero order. By introducing new variables into Stefanescu's equations, the formula for apparent resistivity is obtained in a simpler form, avoiding summation of infinite series. The formula can be further simplified if only approximate values are sought. Using the method of similarity formulas for varying electrode spacing are obtained so that it is possible to collate the results obtained with different arrangements of electrodes. The last section of the article contains examples of the use of the suggested method.—*S. T. V.*

13234. Clark, A. R., and Salt, D. J. The investigation of earth resistivities in the vicinity of a diamond drill hole: Geophysics, v. 16, no. 4, pp. 659–665, 1951.

One current electrode and two potential electrodes are placed in a diamond-drill hole with four current electrodes on the surface placed symmetrically about the hole on E-W and N-S lines. By means of electrical images an expression is derived for the in-hole potential difference for a conducting sphere near the drill hole and in a poorly conducting medium.

In a field test where the size and shape of small sulfide ore bodies were accurately known, the ratios of potential for north and south measurements and for west and east measurements for various depths served to determine the direction of the ore bodies from the drill hole. From resistivity profiles for expanding and fixed electrode systems it was possible to determine depths.—*R. G. H.*

13235. Petrucci, G. Lo studio dei terreni di fondazione per mezzo dei sondaggi elettrici [Exploration of foundation sites by electrical sounding]: Gior. del genio civile, v. 89, fasc. 4, pp. 291–296, 1951.

The method used consists of determining the apparent resistivity of the ground, increasing electrode separation by very small steps, and covering in regular, relatively dense profiles the whole area under investigation. Measurements are made with alternating current. Variation of resistivity in corresponding points of parallel profiles indicate subterranean changes from aquiferous to impermeable formations. In certain doubtful cases drilling of a few holes is recommended. Three examples of the use of this method are given. The object of the first assignment was to explore the possibility of finding sources of water in an isolated depression, in the others the problem consisted of establishing the absence of subterranean springs near the sites of a projected dam and an important engineering structure. The method is applicable where the soil is covered with at least one foot of humus, but in areas covered with lava or bare rocks it should not be employed.—*S. T. V.*

13236. Vecchia, Orlando. Prospezione geofisica su di un filone di Zn e Pb al Mottarone, in Provincia di Novara (Piemonte) [Geophysical exploration of a lead-zinc vein at Mottarone in the Provincia di Novara (Piemonte)]: Riv. Geofis. Appl., v. 12, no. 1, pp. 15–20, 1951.

Electrical resistivity and self-potential surveys were made on Monte del Falò between Lago Maggiore and Lago d'Orta, on the site of an abandoned mine. The immediate aim of the exploratory work was to investigate the position and the

extent of several quartz veins containing lead and zinc sulfide ores which had been cut by underground galleries in previous mining work. A zone of minimum resistivity was mapped and subsequently found to correspond to an ore deposit. Spontaneous potential curves taken over the same profiles also showed a sharp dip at two points over the vein. The spontaneous potential curve also shows a negative anomaly of 150 mv which is apparently not related to sulfide mineralization.—*S. T. V.*

13237. Satō, Kōnosuke. Geophysical exploration of the Black Ore Deposits ("Kurokō") at Hanaoka Mine, Akita prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 2, no. 1, pp. 1–5, 1951.

Seismic and electric surveys have been made for ore deposits covered by the Quaternary formation. The ores in the Hanaoka mine are massive replacement deposits. The country rock is chiefly a green tuff, and it is supposed that basaltic andesite has acted as a cap rock on these ore deposits. Some indications of spontaneous polarization from the deposits at shallow depth have been recognized. Values of the negative centers are from 50 to 200 mv. Seismic surveys were made to determine the structure of the basaltic andesite.—*M. C. R.*

13238. Murozumi, M. Electrical prospecting on Yokota Mine, Fukushima prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 2, no. 1, pp. 51–64, 1951.

Self potential and resistivity surveys were made in four areas for the purpose of discovering unknown ore deposits. An extension of the Shijukuin ore deposits was recognized, and some indications of buried unknown deposits were found.—*M. C. R.*

13239. Satō, Mitsunosuke, and Shibatō, Kihei. Geophysical prospecting in Oshirabetsu Mine, Tokachi Province, Hokkaido [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 3, pp. 22–28, 1950.

Electrical and magnetic surveys of the Oshirabetsu graphite mine, Hokkaido, have been made. In the self-potential survey a conspicuous negative-anomaly zone was found to extend about 200 m west from the second adit. The value of the negative center was 1000 mv. From the resistivity method, relatively shallow ore deposits are to be expected near the second adit and at the western part of the natural-potential anomaly zone. From the magnetic results, pyrrhotite should be mainly at the south side of the ore deposit. The ore body is estimated to be about 200 m in length from east to west, 5 to 39 m in width, and to have fair extension in depth.—*M. C. R.*

RADIOACTIVE METHODS

13240. Russell, W. L., and Scherbatskoy, S. A. The use of sensitive gamma-ray detectors in prospecting: Econ. Geology, v. 46, no. 4, pp. 427-446, 1951.

Ionization chambers, proportional counters, Geiger counters, and scintillation counters can be used as radiation detectors in searching for radioactive ores. The most suitable detector should be light, small, and capable of measuring ordinary gamma-ray activity of rocks at ordinary walking speeds to within about 10 percent. The most important factor in interpreting the results of a gamma-ray survey is the recognition of anomalies, herein defined as radiation intensities unexpectedly large for the associated field conditions. Proper interpretation of anomalies requires knowledge of the characteristic radiation intensities of rock types.

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Allowance must also be made for the effect of topography, weathering, and climate. Although surface gamma-ray measurements are very useful for finding uranium ores, their value depends mainly on the accuracy with which the anomalies are interpreted.—*F. W. S.*

13241. Belcher, D. J., Cuykendall, T. R., and Sack, H. S. The measurement of soil moisture and density by neutron and gamma-ray scattering: U. S. Civil Aeronautics Administration Tech. Devel. Rept. 127, 20 pp., 1950.

Moisture and density of soils may be measured by use of a device consisting of a radioactive source and detector lowered into a 1-inch metal tube driven into the ground. Fast neutrons emitted by the source are converted by impact with water molecules to slow neutrons, the number of slow neutrons being proportional to the water content of the surrounding soil. A similar arrangement, using gamma-ray emanation, measures soil density. Continuous and automatic recording is feasible. Laboratory and field tests show the accuracy of the method equals or exceeds that of standard procedures.—*M. C. R.*

13242. Ridland, G. C. Radioactivity at the Caribou Silver Mine, Boulder County, Colorado: Am. Inst. Min. and Met. Eng., Trans., v. 187, pp. 98–101, 1950.

Radioactivity on the surface and within the Caribou mine was measured using a Geiger-Müller counter. The surface survey failed to detect any evidence of above-normal gamma-ray intensity over the country rock. In the mine at the 1,040-foot level, an anomaly was found. Throughout the area the quartz-monzonite host rock showed a normal gamma-ray count.—*L. E. B.*

LOGGING AND BOREHOLE METHODS

13243. World Oil. Nomograms for quantitative analysis of electrical logs: v. 132, no. 5, pp. 131–134, 1951.

Two nomographs for determination of water saturation and porosity have been developed for use in analytical investigations of electrical-log data. Examples of the use of the nomograms are given.—*L. E. B.*

13244. Barber, R. C. Porosity-permeability check by electric log: World Oil, v. 131, no. 3, pp. 165–166, 168, 172, 175, 1950.

In the secondary recovery of oil by water flooding, accurate information is needed on porosities and oil saturations and on permeabilities or water-input rates. Work by C. A. Doh in Illinois has shown that electrical logging of a well under two different hydrostatic heads gives two logs showing a difference in resistivity which seems to be correlative with permeability. Operations in the Appalachian region have shown an initial decrease in resistivity and later increase during flooding, the decrease being a function of porosity and the increase of the relative permeability of the formations to water. The technique used in the Bradford field is based on the use of a short lateral curve and a careful control of the amount of water in the hole. The first resistivity curve is obtained immediately after the sand is covered with water and the second with an additional head of water selected so as not to exceed the flooding pressure. The third run is made several hours after the well has been filled with water. Porosity determinations from the differential resistivity between second and first runs showed fair correlation with those made by core analysis. Differential resistivities between

third and second runs have been used with some sucess to estimate the water input or permeability of the sand layers.—*M. C. R.*

13245. Kokesh, F. P. Gamma-ray logging: Oil and Gas Jour., v. 50, no. 12, pp. 284–300, 1951.

The basic principles of operation and interpretation of gamma-ray logging are discussed. Such factors as counter efficiency, effect of size and shape of counters, statistical variations, and time constants are considered, both theoretically and in the light of examples from actual records.—*M. C. R.*

13246. Tittle, C. W., Faul, Henry, and Goodman, Clark. Neutron logging of drill holes: the neutron-neutron method: Geophysics, v. 16, no. 4, pp. 626–658, 1951.

Experiments were performed to determine the distribution of thermal neutrons and of indium resonance neutrons in continuous hydrogenous media and in pipes passing through hydrogenous media. Included in the study were water, brine, mixtures of sand and water, and mixtures of sand and brine. Experiments in a continuous typical barite drilling mud showed that the neutron distributions were essentially the same as in water. Also, from the point of view of these experiments oil and fresh water are nearly identical.

These experiments show that well fluid (and, by inference, cement) imposes serious limitations on the sensitivity and accuracy of the neutron-neutron logging method. The indium resonance neutron response (or, in general, the intensity of epithermal neutrons) is a more reliable indicator of hydrogen content of the formation than is the thermal neutron response. The neutron-neutron method of chlorine determination was found to be not sensitive enough to be useful with brines of the concentrations ordinarily found in reservoirs.—*Authors' abstract.*

13247. Kerr, A. J. Applications of radioactivity well logging in west central Texas: Tomorrow's Tools Today, v. 17, no. 3, pp. 28–30, 1951.

Radioactivity well logging including both gamma-ray and neutron measurements can provide additional data on the depth to and thickness of producing zones for perforation and treatment (hydra-frac or strata-lift). The neutron curve, calibrated in terms of porosity, offers porosity information in a given field without the expense of an extensive coring program.—*F. W. S.*

TECHNICAL AIDS

13248. Gardiner, J. T. Use of shaped charge process for open hole shooting: World Oil, v. 131, no. 3, pp. 99–103, 1950.

The use of shaped explosive charges in well shooting, involves the control and concentration of detonating forces at one particular point. Advantages are greater safety and zone coverage, less cleanout time, and satisfactory performance at higher temperatures than nitroglycerin. Shaped charges may be used in both open and cased holes.—*L. E. B.*

13249. Antsyferov, M. S. Vibrating table for the testing of vibrometers within the audio frequency [in Russian]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 5, pp. 31–39, 1951.

A description is given of a vibrating table designed for the calibration of vibrometers and seismographs. The table can produce vertical vibrations with frequencies ranging from 5 to 10,000 cycles per second. Vibrations of the table are

produced by an electrodynamic exciter, consisting of a magnetizing coil and an oscillating armature. The resulting amplitudes of the table are measured electrically.—*S. T. V.*

13250. Schuler, Max. La conservation de l'heure et son importance [Precise timekeeping and its importance]: Annales Guébhard-Séverine 1947–1948, pp. 45–51, 1951.

Variations in the length of the sidereal day can be determined by two extremely precise instruments, the pendulum clock and the new quartz-crystal clock. A pendulum clock, recently designed and installed at the University of Göttingen, consists of two pendulums, with two masses fixed at the ends of the oscillating rods and provided with an attachment producing electromagnetic impulses controlled photoelectrically at each oscillation. The rods and masses are made of invar. The pendulums are suspended in an evacuated chamber in which the temperature is kept constant thermostatically within limits of ± 0.1 degree. The use of two masses makes the period of oscillations independent of the position of the knife edge, and friction caused by the knife edges is so small that the pendulum, once started, continues oscillating for six hours.

By using an electronic oscillograph it is possible to make readings on this clock with an error less than few hundred thousandths of a second. The greatest drawback of this clock is the change of the length of the rod caused by some molecular rearrangements of invar, producing from time to time discontinuous changes in the daily rate of the clock. This necessitates the use of three similar clocks installed together, increasing the cost and creating difficulties in servicing them. Another drawback, common to all pendulum clocks, is their sensitivity to even feeble seismic shocks as well as to changes of gravity caused by stellar bodies or by deep seated displacements of subcrustal masses. The quartz clock is also described. In this the controlling element is a crystal of quartz, excited to vibrate with its own very constant natural frequency, independent of gravity force and its variations. For short intervals of time, not exceeding about 30 days, the quartz clock is the most precise time-measuring instrument known. Its daily rate can be made as low as 0.4 sec per day, but after some years of use the elastic properties of the quartz crystal change, resulting in a decrease of the precision of the clock.—*S. T. V.*

PATENTS

GRAVITY METHODS

13251. Borehole gravity meter. Charles H. Fay and Richard R. Goodell, Houston, Tex., assignors to Shell Devel. Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,570,659, issued Oct. 9, 1951.

A gravity meter comprising a housing, a body having a spherical downwardly convex lower face, a second body mounted within said housing having a spherical upwardly concave upper face, resilient means within said housing supporting said first body suspended over said second body, the convex face of said first body being separated from the concave face of said second body by a uniform distance determined by the pull of gravity on said resilient supporting means, said two faces being concentric with regard to the point of suspension of said first body, an oscillator circuit, means electrically connecting said two bodies into said oscillator circuit as the two plates of a condenser, the frequency of said oscillator circuit being controlled by the capacity of said condenser, means for indicating the variations of said frequency occurring in response to changes in the capacity of said condenser as the spacing between said bodies is varied proportionally

to changes in the force of gravity acting on said suspended body, a casing surrounding said housing, and means for supporting said housing for substantial self-leveling within said casing. Claims allowed, 8.

13252. Torsional balance device. William R. Jack, Chagrin Falls, and Emil M. Brinker, Lakewood, Ohio; said Brinker assignor to said Jack: U. S. patent 2,574,395, issued Nov. 6, 1951.

In an apparatus for measuring gravitational forces, a mounting frame, a flexible torsional suspension arm, a manual control secured to one end of said arm for introducing torsion longitudinally of said arm, the other end of said arm being mechanically free and unattached to said frame, a weighted cross arm secured to said suspension arm adjacent the free end of said torsional suspension arm, cooperating means carried by said frame and suspension arm for magnetically supporting the mechanically free end of said suspension arm in spaced relation with the supporting means carried by said frame for maintaining said suspension arm taut and horizontally disposed and indicating means for indicating the position of said cross arm and the torsion introduced in said suspension arm. Claims allowed, 12.

MAGNETIC METHODS

13253. Electrical bridge compensation system for magnetometers. Otto H. Schmitt, Port Washington, and John H. Hidy, Garden City, N. Y., assignors to the United States of America as represented by the Secretary of the Navy: U. S. patent 2,570,870, issued Oct. 9, 1951.

In a compensated magnetometer system for measuring changes other than protracted changes in a magnetic field, a magnetometer sensitive to all changes in said field, a source of compensating current for said magnetometer, and means for controlling the flow of said current from said source to said magnetometer, said means comprising a normally balanced bridge circuit including a pair of variable impedance elements, the input diagonal of said bridge being connected to said current source and the output diagonal of said bridge being connected to said magnetometer, and means operable in response to variations in the output of said magnetometer due to all changes in said field but effective only after a chosen time delay to vary the impedance offered by said impedance elements, said time delay being such that compensation occurs only for protracted changes in said field. Claims allowed, 6.

13254. Automatically recording torque magnetometer. Donald S. Miller, Westfield, N. J., assignor to United States Steel Co., a corporation of New Jersey: U. S. patent 2,574,795, issued Nov. 13, 1951.

A torque magnetometer for measuring the torque exerted by a magnetic field on a specimen of magnetic material comprising a rotor for supporting said specimen for rotation therewith, a magnet for creating the magnetic field, said specimen being located in said magnetic field, a strain gage for measuring the torque exerted by the magnetic field on said specimen, and a connection between said strain gage and said rotor. Claims allowed, 14.

SEISMIC METHODS

13255. Blasting device. Ferdinand De Witt Bickel and Harold Arthur Lewis, Wilmingtom, Del., and Robert Henry Mecklenborg, Philadelphia, Pa., assignors to E. I. du Pont de Nemours & Co., Wilmington, Del., a corporation of Delaware: U. S. patent 2,569,511, issued Oct. 2, 1951.

A mechanically operated timing device for firing charges of explosives in predetermined order and at precise time intervals comprising in combination terminals for connecting said device to a power source; an electric motor; a circuit from said terminals to said motor; a rotatable cam-shaft operatively connected to said motor; at least two electrically energizable relays; circuits from said terminals to said relays; cam-operated circuit-breaking elements connected in series therein with each of said relays and relay-operated circuit-breaking elements, connected in parallel therein with said cam-operated circuit-breaking elements, at least one of said relay circuits also having connected in series therein a circuit-breaking element operated by a different relay; a plurality of firing circuits, each having connected in series therewith a cam-operated circuit-closing element; a blasting circuit connecting said firing circuits to said terminals, said blasting circuit having connected in series therewith at least one relay-operated circuit-closing element; a short circuit containing connected in series a relay-operated circuit-breaking element interposed between said relay operated circuit-closing element in the blasting circuit and said firing circuits; and means for stopping said motor when the said cam-shaft has substantially completed one revolution; the cams on said shaft being so positioned as to (1), operate the circuit-closing elements completing the circuit to the relays which, when energized, close the main circuit and open the short circuit, (2), after the said shaft has attained constant speed, operate the circuit-closing elements in the firing circuit in predetermined order and at equal intervals, (3), operate the circuit-closing elements in the circuit of the relay regulating the circuit of the blasting circuit and short circuit control relays, and, (4), operate the motor stopping means Claims allowed, 3.

13256. Accelerometer unit. Claude M. Hathaway, Littleton, Colo.: U. S. patent 2,570,672, issued Oct. 9, 1951.

An accelerometer comprising a housing formed as a spool having thereon a plurality of electromagnetic windings, a chamber formed at each end of said spool, a plurality of diaphragms each mounted to divide each chamber, each diaphragm having a relatively small aperture therein, a movable magnetic armature mounted in the spool passage interconnecting said chamber, means for adjustably securing said armature to said diaphragm, and a damping fluid filling said chambers and said interconnecting passage. Claims allowed, 5.

13257. Seismic surveying. Josephus Overton Parr, Jr., San Antonio, Tex., assignor to Olive S. Petty, San Antonio, Tex.: U. S. patent 2,570,707, issued Oct. 9, 1951.

In apparatus for use in seismic surveying of underwater formations, the combination with a plurality of detector assemblies each including a detector and a buoyant support for said detector, the combined weight of said detector assembly being not substantially greater nor less than the weight of water displaced by said assembly when completely submerged, of a towing line directly connecting said detector assemblies in spaced relation, floats secured directly to major portion of said line intermediate and beyond said detector assemblies and supporting such major portions of said line at the surface, weights on said line adjacent to and at each side of and spaced from said detector assemblies at points on said line intermediate said floats and detector assemblies, the mass of said weights being sufficient to cause said detector assemblies and that portion only of the line adjacent the detector assemblies to submerge only when the line is slack to form at each detector assembly a depressed bight in the towing line, whereby the detector assemblies are surfaced during towing, and conductors extending from each detector along said line. Claims allowed, 4.

13258. Seismic survey system for submerged areas. Roy Lee Gallaway, Laurel, Miss., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,572,255, issued Oct. 23, 1951.

A seismic surveying system for submerged areas including a marine cable adapted to be towed through the submerging medium, buoys spaced apart from each other and attached to said cable, a weighting chain for each buoy attached by one end thereto with the free end of the chain adapted to drag upon the surface of the submerged area, and seismic detectors each supported in a submerged carrier, said carriers being connected by nonrigid means to said cable and spaced apart along the cable, each detector being in electrical communication with an electrical conductor in association with said cable, the relative weight of the said chains and buoyancy of the combined cable and buoys being such that the upward force of the buoyancy of the combined cable and buoys is greater than zero but less than the downward force of the entire weight of the chains, so that the whole assembly will stabilize at a level where the supporting of a portion of each chain by the ground surface leaves in balance the opposing upward force of the buoyancy and downward force of the unsupported portion of the chains. Claims allowed, 9.

13259. Seismometer system. Frank D. Case, Reading, Mass., assignor to Diamond Instrument Co., Wakefield, Mass., a corporation: U. S. patent 2,576,775, issued Nov. 27, 1951.

A system of earth tremor detecting assemblies comprising, in combination, a plurality of seismometers, the seismometers being adapted to pick up earth tremors and transmit them through transducers and amplifying means to a recording assembly, each seismometer including a vertical column and a transducer affixed to an adjustable horizontal platform, seismometer elements operatively suspended on each column for, respectively, detecting longitudinal, transverse and vertical earth disturbances, each assembly of said elements including a horizontally disposed pendulum, a vane on the pendulum adapted to be oscillated between the poles of a transducer by movements of the pendulum, means for adjustably positioning the platform in the horizontal plane, means for adjustably suspending the seismometer elements on the column and on the pendulum, magnetic damping means mounted on the platform and adapted to be adjustably disposed in relation to the pendulum, the transducer poles being adjustably mounted in relation to the pendulum vane, air damping means including apertures in the vane, and electronic means adapted to maintain the elements of the assembly in accurate relation to each other. Claims allowed, 3.

13260. Submarine compressional wave receptive apparatus. Horace M. Trent, Alexandria, Va.: U. S. patent 2,576,155, issued Nov. 27, 1951.

A receptive apparatus for submarine compressional waves comprising a base plate, a dome mounted on the base plate to form with the plate a fluid tight chamber, a body of liquid contained in the chamber formed by the dome and plate, a supporting tube mounted on the base plate within the chamber and extending from near the center of the plate to near the center of the chamber, a cork-imbedded directional hydrophone situated in the chamber and an elastic flexible cable extending through the supporting tube to the cork-imbedded hydrophone and constituting the sole support therefor, the length of cable extending from the unmounted end of the tube to the hydrophone and the over-all size of the cork-embedded hydrophone being limited to prevent contact of the hydrophone with the dome, whereby the hydrophone is floated upwardly from the unmounted end of the supporting tube in various positions of the dome and base plate without contacting the dome. Claims allowed, 2.

13261. System of seismic recording. James E. Hawkins, Tulsa, Okla., assignor, by mesne assignments, to Seismograph Service Corp., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,578,133, issued Dec. 11, 1951.

A system for first producing on an elongated magnetizable medium a composite magnetic record of a plurality of phase-related seismic signals which are separately collected in the presence of noise at different points, for then separately reproducing the phase-related signals in their original phase relationship and for mixing the reproduced signals to produce resultant signals of a predetermined character; which comprises a magnetic recording head for magnetically recording signals on said medium, a plurality of dispersed signal pickup devices operative separatively to pick up said phase-related seismic signals and the accompanying noise at said different points, means for separately modulating carriers having different frequencies with said signals and the accompanying noise, a composite signal channel for concurrently impressing the modulated carriers upon said recording head, reproducing means including signal separating channels individually corresponding to said carrier frequencies and each provided with a carrier selective filter followed by a signal and noise demodulator, a mixing network including means for mixing at least two of the demodulated signals to produce a resultant signal, and means included in said signal separating channels at points following said demodulators for preventing at least certain frequency components of the noise from entering said mixing network. Claims allowed, 9.

13262. Seismograph blaster time breaker circuit. Cecil L. Brownlow, Bartlesville, Okla., assignor to Phillips Petroleum Co. a corporation of Delaware: U. S. patent 2,578,877, issued Dec. 18, 1951.

In a seismic wave generating and recording system the combination comprising a generating station, a recording station, and a signal system for transmitting signals from one station to the other, means for moving a recording medium at said recording station, means to make indications on said medium at predetermined intervals of time, a rotatable cam member driven by said moving means, pulse-generating means including a set of contacts actuated by said rotatable cam member to make a pulse in said signal system at a predetermined interval of time from the time of making one of said indications, means to generate seismic waves at the generating station comprising an explosive charge, an electric heating element disposed to set off said explosive charge and to be broken in the resulting explosion, and firing-current-generating means to generate sufficient electric current to heat said element enough to set off said charge connected to said element by a first electric circuit containing a first open switch, first switch-closing means comprising a second electric circuit responsive to any of said pulses to close said first open switch, a third electric-circuit means containing a second open switch connecting said second circuit means to said signal system for reception of said pulses only when said second open switch is closed, and means connected to said firing-current-generating means disposed to close said second open switch when sufficient electric current is normally being generated, whereby said charge is set off only in response to the actuation of said firing-current-generating means, but at a time set by one of said pulses, means for impressing a signal on said signal system actuated by an open circuit in said heating element immediately said element is broken in said explosion, means for making indications on said medium responsive to said signal to record the time of the explosion, means for detecting the arrival of seismic waves by generating electric current, and means responsive to current from said last mentioned means for actuating said indicating means to indicate the time of arrival of said seismic waves on said medium. Claims allowed, 9.

ELECTRICAL METHODS

13263. Determination of ground constants. Maxwell K. Goldstein, Washington, D. C.: U. S. patent 2,575,340, issued Nov. 20, 1951.

An apparatus for determining electrical characteristics of the earth's crust, comprising; means generating frequency-modulated radio frequency energy, an antenna system operative to deliver the radio-frequency energy thus generated to the earth's crust, a plurality of receiving elements located at various points in the earth's crust equidistant from said antenna system operative to receive part of the generated energy primarily after direct propagation through selected portions of the earth's crust, a receiving system responsive to the frequency differences between the transmitted and received signals for amplifying the received signals, switching means for connecting individually and sequentially each of said receiving elements to said receiving system, and indicator means operable from the output of said receiving system for indicating the relative rate of energy propagation through each of the selected portions of the earth's crust. Claims allowed, 3.

13264. Geophysical surveying. Frederick W. Lee, Owings Mills, Md.: U. S. patent 2,575,349, issued Nov. 20, 1951.

The method of geophysical surveying which comprises establishing a potential contact with the earth at a center of observation, establishing at least two pairs of current contacts with the earth at the ends of current base lines crossing one another at said center and with said current contacts remote from said center, supplying currents to said respective pairs of current contacts, adjusting said currents to produce resultant potential gradients in the earth corresponding to a phantom current base line rotated in azimuth about said center relative to the established base lines, and measuring the potential differences between said center potential contact and points on said phantom base line. Claims allowed, 9.

ELECTROMAGNETIC METHODS

13265. Means and method for electromagnetic-wave investigations. William M. Barret, Shreveport, La., assignor to Engineering Research Corp., Shreveport, La., a corporation of Louisiana: U. S. patent 2,573,682, issued Nov. 6, 1951.

In a method of conducting electromagnetic-wave investigations, the steps of: generating electromagnetic waves with a wave-generating means, propagating said waves with a radiator positioned above and adjacent to the earth's surface and electrically coupled to said wave-generating means, receiving said waves with a receiver located in or above the air-earth interface and spaced apart from said radiator, maintaining at a predetermined value the amplification constant of said receiver, varying the frequency of the waves emitted by said wave-generating means, measuring the magnitude of the output of said receiver, and simultaneously varying the length and effective height of said radiator in a manner adapted to maintaining substantially constant at said receiver the amplitude of the waves arriving through the air from said radiator. Claims allowed, 4.

RADIOACTIVE METHODS

13266. Method and apparatus for measuring strong alpha emitters. Emilio G. Segrè, Santa Fe, N. Mex., assignor to the United States of America, as represented by the U. S. Atomic Energy Commission: U. S. patent 2,573,069, issued Oct. 30, 1951.

A device of the character described having in combination, an alpha-particle-emitting material, said material being distributed in a thin layer over a substantial area, a second material capable of emitting neutrons upon bombardment by alpha particles from said first material, said second material being of planiform configuration, the area thereof corresponding generally to the area of said first mentioned material, and disposed in spaced relation to said first material within the effective range of alpha particles emitted therefrom, and a third material capable of becoming radioactively excited upon bombardment by neutrons emitted from said second material, said third material being of planiform configuration and of area corresponding to the area of said first and second materials and supported in spaced relation therewith beyond the effective range of alpha particles from said first material and within the effective range of neutrons from said second material. Claims allowed, 2.

13267. Ionization chamber. John A. Victoreen, Cleveland, Ohio, assignor to Victoreen Instrument Co., Cleveland Ohio: U. S. patent 2,573,999. issued Nov. 6, 1951.

A pocket chamber comprising a barrel having a carbon-impregnated liner therein, a bottom closure and an open top, an electrode supported in said barrel and insulated therefrom, a removable cap slidable into the open top and means to seal the cap to the top. Claims allowed, 13.

13268. Radiation detection and measuring apparatus and method. Donald W. Engelkemeir, Sante Fe, N. Mex., and Nathan Sugarman, Chicago, Ill., assignors to the United States of America as represented by the U. S. Atomic Energy Commission: U. S. patent 2,574,632, issued Nov. 13, 1951.

Apparatus of the class described comprising support means including a radiation impermeable member having a surface adapted to support a sample of radioactive material, means operable to provide a uni-directional magnetic field across the sample mounting surface of the member, the intensity of said field being such that the direction of the emitted particles will be substantially reversed in direction and positive and negative beta particles emitted from such sample will be deflected in opposite directions, means to detect beta particles, means to mount the detecting means contiguous to the member, said means providing two mounting positions for the radiation detecting means, said mounting positions being on opposite sides of the member and positioned from the member in a direction normal to the magnetic field, and a shield having a movable portion mountable adjacent to the member to shield the detecting means. Claims allowed, 8.

13269. Radiation detection instrument. William A. Hopkins, Columbus, Ohio, and Howard W. Gilbert, Bethesda, Md.: U. S. patent 2,578,703, issued Dec. 18, 1951.

A pocket-size portable radiation detector comprising a casing having an eyepiece, a pair of screens disposed within said casing in one plane normal to the axis of vision and at opposite sides of said axis, one of said screens being inherently luminescent and the other being treated to glow when exposed to radioactivity, and a panel structure arranged between said eyepiece and said screens and in parallelism with the latter, the half of said panel structure associated with the inherently luminescent screen being of graduated transparency from one edge to an opposite edge, said panel structure carrying two series of opaque characters disposed in rows behind said screens. Claims allowed, 4.

13270. Neutron density indicator device. Walter H. Zinn, Chicago, Ill., assignor to the United States of America as represented by the U. S. Atomic Energy Commission: U. S. patent, 2,579,994, issued Dec. 25, 1951.

Neutron-intensity indicating means comprising two members of dissimilar metals joined together to provide a thermocouple, said metals having low neutron capture properties and being capable of developing thermoelectromotive forces at a junction thereof, a coating of nonfissionable material having higher neutron capture properties than the thermocouple members disposed on at least one junction of the thermocouple members, thereby providing a hot junction for the thermocouple. Claims allowed, 7.

LOGGING AND BOREHOLE METHODS

13271. Alternating-current electro-logging. Russell G. Norelius, Huntington Park, Calif., assignor to Lane-Wells Co., Los Angeles, Calif., a corporation of Delaware: U. S. patent 2,569,867, issued Oct. 2, 1951.

In electrical-logging apparatus wherein an alternating current is conducted through an input conductor contained in a conductor cable to an input current electrode in a borehole and thence through the surrounding formations to another electrode to establish an electric field in the surrounding formations around said input current electrode and wherein a portion of such electric field is tested by a pair of spaced, potential pick-up electrodes in said borehole and the potential thus picked up is conducted to the top of said borehole through a pair of conductors contained in said cable to measuring apparatus at the surface exterior to said borehole, the apparatus comprising: a generator of an alternating current having a wave form which includes a constant amplitude portion and a varying amplitude portion in the cycle; electrical connection from said generator to said other electrode and to said input conductor adjacent the top end of said conductor cable whereby said alternating current may be conducted through said conductor to said input current electrode adjacent the other end of said cable and thence through the surrounding formations to said other electrode; an electric meter; connections from said pair of conductors contained in said conductor cable to said meter whereby a potential may be applied to said meter which is representative of a potential appearing between the conductors of said pair of conductors; and switching apparatus for periodically grounding said pair of conductors for a predetermined fractional portion of the cycle. Claims allowed, 12.

13272. Drill hole and underground resistivity method. Arthur A. Brant, Toronto, Ontario, Canada, assignor to Geophysical Exploration Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,571,529, issued Oct. 16, 1951.

An electrical-potential method of drill hole exploration comprising electrifying the subsurface with a direct-current source by means of current electrodes spaced either side of a drill hole, measuring potentials along the drill hole to indicate the presence of a conductor anomaly and to locate it generally in one direction relative the drill hole, rotating the current electrodes to electrify the subsurface in a substantially orthogonal direction, measuring potentials along the drill hole with the subsurface electrified in said orthogonal direction to locate the azimuth of said anomaly, electrifying the subsurface along said drill hole and measuring potentials along the drill hole with the subsurface electrified in the direction of the hole to identify said anomaly as a good or poor conductor enabling its azimuthal locations to be confirmed. Claims allowed, 15.

13273. Well logging system. Walton J. Greer, Houston, Tex., assignor to Halliburton Oil Well Cementing Co., Duncan, Okla.: U. S. patent 2,573,133, issued Oct. 30, 1951.

In an electrical system for making a natural potential log and a plurality of resistivity logs of an oil well or the like simultaneously, in which electrodes are lowered into a borehole on a single conductor electrical cable, power is sent down the cable from an alternating-current source at the surface of the ground to cause current to flow through fluid in the borehole and through earth formations and signals indicative of the natural earth potential and of the resistivity of the formations are transmitted up the cable to measuring apparatus at the surface, the combination with a plurality of pick-up electrodes in the borehole of a matching section for impressing all of said signals upon the conductor of the cable and a plurality of units for converting the alternating-current potentials impressed upon certain of said pick-up electrodes by the flow of current into frequency-modulated signals, each of said units having an input from one or more of said pick-up electrodes and having an output into said matching section and each of said units consisting of a signal-receiving circuit for converting changes in alternating-current potential into changes in resistance, an oscillator circuit for generating carrier waves connected to said signal-receiving circuit and a buffer amplifier connected to said oscillator circuit and said matching section, the arrangement being such that the changes in resistance of said signal-receiving circuit modulate the frequency of the carrier waves of said oscillator circuit. Claims allowed, 6.

13274. Electric well logging system. Walton J. Greer, Houston, Tex., assignor to Halliburton Oil Well Cementing Co., Duncan, Okla.: U. S. patent 2,573,137, issued Oct. 30, 1951.

In an electrical system for making simultaneously a plurality of resistivity logs of earth formations along a borehole, the combination with a single conductor cable having current electrodes and pick-up electrodes at its lower end of a source of alternating current at the surface of the ground connected to the conductor of the cable and arranged to cause a formation current to flow between said current electrodes, frequency modulation signalling circuits connected to said pick-up electrodes and the conductor of the cable for transmitting signals to measuring apparatus at the surface of the ground and a frequency converter at the lower end of the cable for causing the formation current to have a different frequency than that transmitted through the conductor of the cable from said source. Claims allowed, 6.

13275. Apparatus for wear indicating and logging while drilling. Everett A. Johnson, Park Ridge, Ill., assignor to Standard Oil Co., Chicago, Ill., a corporation of Indiana: U. S. patent 2,575,173, issued Nov. 13, 1951.

An apparatus including a drill bit having cutting edges, a recess in one of said edges, a passage extending from within said bit and in communication with said recess, an insulated conductor extending within said passage and having a terminal exposed within said recess, a separable plug of electrical insulating material electrically sealing the said recess, and an electrical circuit including a current source, a current responsive indicator and said conductor in series, whereby wearing away of the cutting edge to an extent such as to remove the plug from the recess exposes the terminal of the conductor for closing the electrical circuit and producing a signal on said indicator. Claims allowed, 4.

13276. Shockproof case for borehole measuring instruments. Raoul J. Bethancourt, Corpus Christi, Tex., assignor to Sun Oil Company, Philadelphia, Pa., a corporation of New Jersey: U. S. patent 2,577,599, issued Dec. 4, 1951.

A shock-absorbing housing for instruments used in measuring and recording borehole information in well-drilling operations adapted to be suspended by a wire line comprising, in combination: a tubular chamber constructed to receive and enclose said instruments; a nose plug divided into shock-absorbing and connector members detachably attachable to the lower end of said chamber, said shock-absorbing member including a metallic nose piece, a plurality of slotted resilient disks above said nose piece to absorb vertical shock, a metallic body section above and adjacent said resilient disks, a longitudinally movable pin centrally disposed in said body section and through said resilient disks connecting said nose piece to the body member in alignment therewith, a plurality of resilient rings of a diameter larger than said body section compressed between the shock-absorbing and connector members to absorb lateral shock, and the connector member constructed to attach said shock-absorbing member to the instrument chamber; a tail plug longitudinally and concentrically apertured to receive said suspending line and divided into shock-absorbing and retainer members detachably attachable to the upper end of said chamber, a resilient sleeve within the suspending line aperture of the shock-absorbing member enclosing the suspending line and adapted to absorb vertical operating shocks, a plurality of resilient rings of a diameter larger than said shock-absorbing member compressed between the shock-absorbing and retaining members to absorb lateral shock, and said retainer member threaded to engage said shock-absorbing member above said resilient rings. Claims allowed, 3.

13277. Subsurface flowmeter. Frank Morgan, Fox Chapel, Denzel W. Reed, Penn Township, Allegheny County, and Morris Muskat, Oakmont, Pa., assignors to Gulf Research and Devel. Co., Pittsburgh, Pa., a corporation of Delaware: U. S. patent 2,580,182, issued Dec. 25, 1951.

A flow meter comprising a housing adapted for being lowered into a well and having a passageway extending longitudinally therethrough, means carried by said housing to induce well fluid to flow through said passageway, semiconductor means disposed in the said passageway in the path of said fluid and having the characteristic that its electrical resistance decreases in a nonlinear manner with increase in operating temperature, means electrically connected to said semiconductor means for maintaining a constant electric current flowing through said semiconductor means, and indicating means electrically connected to said semiconductor means responsive to variations in electrical resistance thereof, whereby the characteristics of said fluid flow may be determined. Claims allowed, 8.

TECHNICAL AIDS

13278. Electrical analogue. Burton D. Lee, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,569,816, issued Oct. 2, 1951.

In determining field distribution in an electrical device, the improvement which comprises imposing on a pool of electrolyte corresponding in shape to a section of the device electrical potentials corresponding in magnitude and location to field forces acting upon the section, exploring the pool by moving at least one electrode therein in a direction corresponding to that extending across the section

to locate a line of equipotential points in the pool, moving the electrode similarly in the pool to locate another line of equipotential points differing from the potential of the first line, plotting current flow lines normal to the equipotential lines thus located on a chart of the section, locating points of equal electrical gradient on the flow lines in the pool thus located by electrical measurement of the gradient along the lines, and plotting the points of equal gradient thus located on the chart. Claims allowed, 4.

13279. Electrical analogue. Alexander Wolf and Burton D. Lee, Houston, Tex., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,569,817, issued Oct. 2, 1951.

In a device for determining the condition of a force system operating at least approximately in accordance with Laplace's equation and having an electrically conductive body the shape of which is analogous to the system and means for impressing across the body an electrical potential analogous to the force impressed upon the system, the combination which comprises chart-supporting means, a rotatable probe member having at least three electrical contacts spaced from and out of line with each other and arranged to contact the body, one of the contacts being disposed on the axis of rotation of the probe member, means for measuring the potential between a first set of two of the contacts, means for measuring the potential between another set of two of the contacts which define a line transverse to that defined by the first set, a rotatable marker member having a plurality of markers spaced from each other and disposed adjacent the chart with one of the markers disposed on the axis of rotation of the marker member, means for contacting the markers with the chart, means for moving the probe member and the marker member in unison to corresponding positions respectively on the body and on the chart and means for rotating the probe member and marker member in unison through corresponding angles. Claims allowed, 16.

13280. Method and means for correcting sensitivity drift of amplifiers. Norman R. Gunderson, Pasadena, Calif.: U. S. patent 2,570,665, issued Oct. 9, 1951.

A method of compensating for changes in response characteristics of a multiplier phototube and amplifier controlling said multiplier phototube during a scanning operation, which comprises: periodically interrupting the control of said multiplier phototube by said amplifier and simultaneously subjecting the multiplier phototube both to scanning light modulated by a standard density and to a predetermined potential and adjusting the intensity of the scanning light in accordance with the response of the phototube and amplifier while under the influence of said light and predetermined potential. Claims allowed, 19.

13281. Locking mounting for galvanometers. William S. Staff, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,571,776, issued Oct. 16, 1951.

A system for mounting a barrel-type galvanometer, comprising a cylindrical housing therefor, an annular groove in said housing, and an insulated terminal at one end of said housing, a permanent magnet, a pole piece shaped to receive said housing, a spring contact insulated from said magnet and extensible along the axis of said aperture, a second spring contact insulated from said first named contact equal in thickness to the axial width of said annular groove and operative transversely of said aperture whereby said second named spring is received by

said groove to position said galvanometer in said aperture to maintain said first-named spring in compression and in contact with said insulated terminal without interfering with rotation of said galvanometer about its longitudinal axis. Claims allowed, 10.

13282. Circuit for multiple channel recording galvanometers. William H. Lewis, State College, Pa., assignor, by mesne assignments, to the Pennsylvania Research Corp., a corporation of Pennsylvania: U. S. patent 2,577,472, issued Dec. 4, 1951.

A system for controlling a multiplicity of galvanometers for recording adjacent light traces on film comprising a multiplicity of input circuit channels, a diode rectifier including a cathode and an anode individual to each of said channels, a multiplicity of electron tube amplifiers each including an anode, a control grid and a cathode, an output circuit individual to the anode and cathode of each of said amplifiers, a galvanometer individual to each of said output circuits, a connection between the anode of the individual diode rectifiers and the control grid of the respective electron tube amplifiers, a circuit extending between the anode of one diode rectifier in one of said channels and the cathode of the diode rectifier in the adjacent channel, a connection between said last mentioned circuit and the control grid of an additional electron tube amplifier, and a galvanometer connected with the output of said last mentioned amplifier. Claims allowed, 4.

13283. Pendulum compensator. Raymond T. Cloud, Tulsa, Okla., assignor to Stanolind Oil and Gas Co., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,577,875 issued Dec. 11, 1951.

A surveying apparatus which is adapted to be carried on a vehicle comprising a pendulum rotatably mounted on a substantially horizontal axis which is substantially transverse to the direction of motion of said vehicle, a generator of electric current which is adapted to produce a current proportional to the time derivative of the velocity of said vehicle, a torque compensator including a permanent magnet attached to said vehicle and having a coil wound on a cylindrical iron core connected with said generator and rotatably associated with said pendulum and having at least a portion which rotates within the magnetic field of said permanent magnet, a pole piece on said permanent magnet having a curved face which is substantially symmetrical about a transverse plane, the spacing between said face and said core varying substantially inversely as the cosine of the angle the plane of said coil makes with said transverse plane whereby a restoring torque is produced on said pendulum which is substantially proportional to the cosine of the angle of slope of the path over which said vehicle travels. Claims allowed, 5.

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ERRATA

Bulletin 981–C, abstract 13085, first line should read:

13085. Prospecting. Charles F. Teichmann, Mount Vernon, New York, and Burton

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GEOLOGICAL SURVEY BULLETIN 981

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UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

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